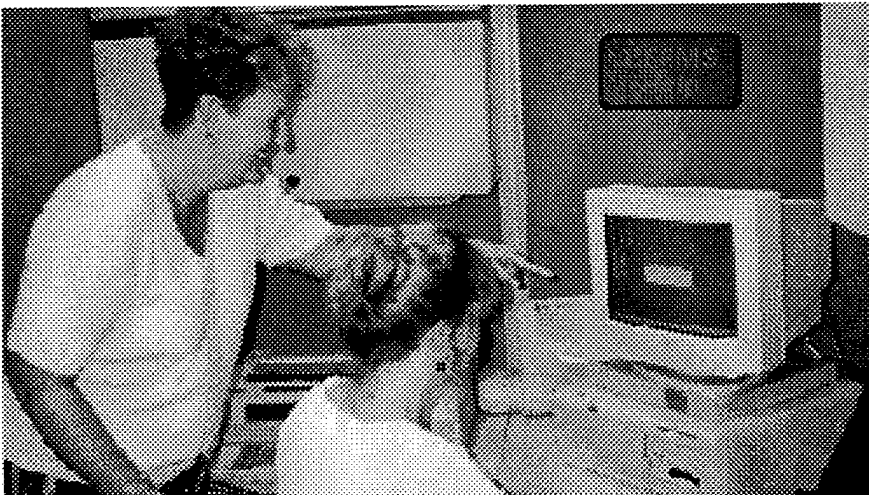
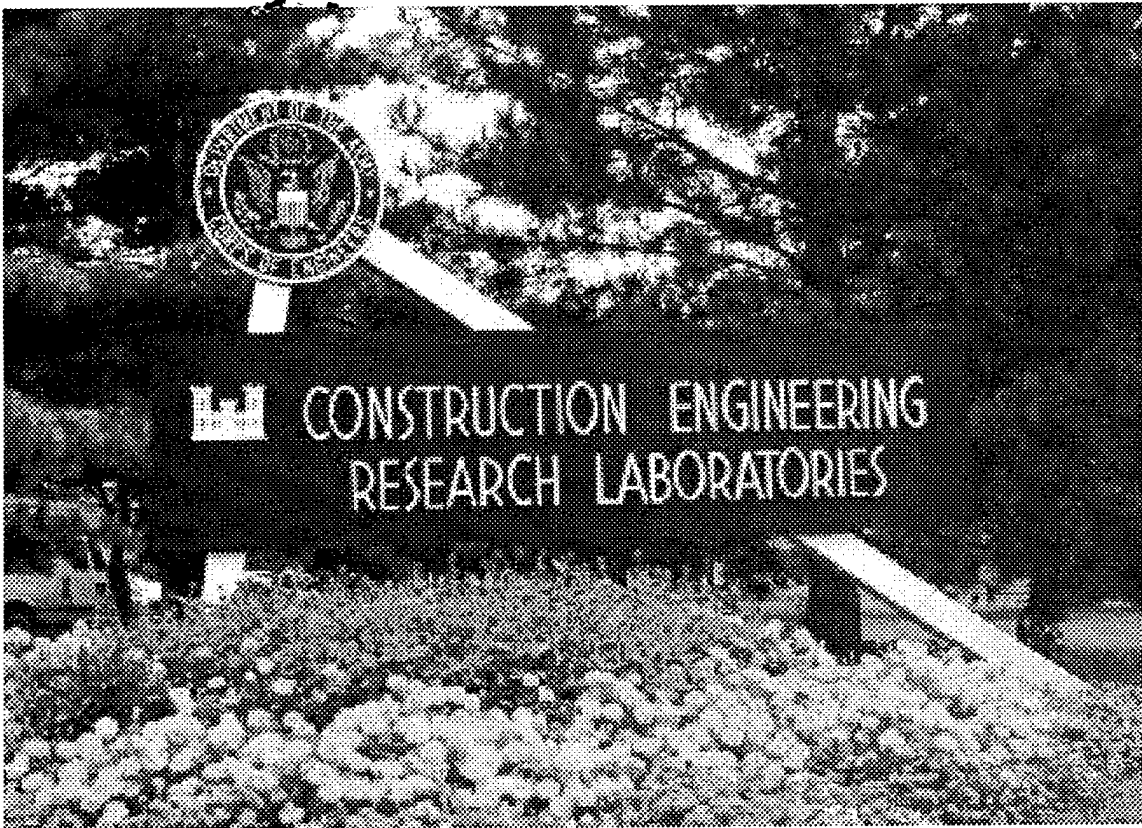


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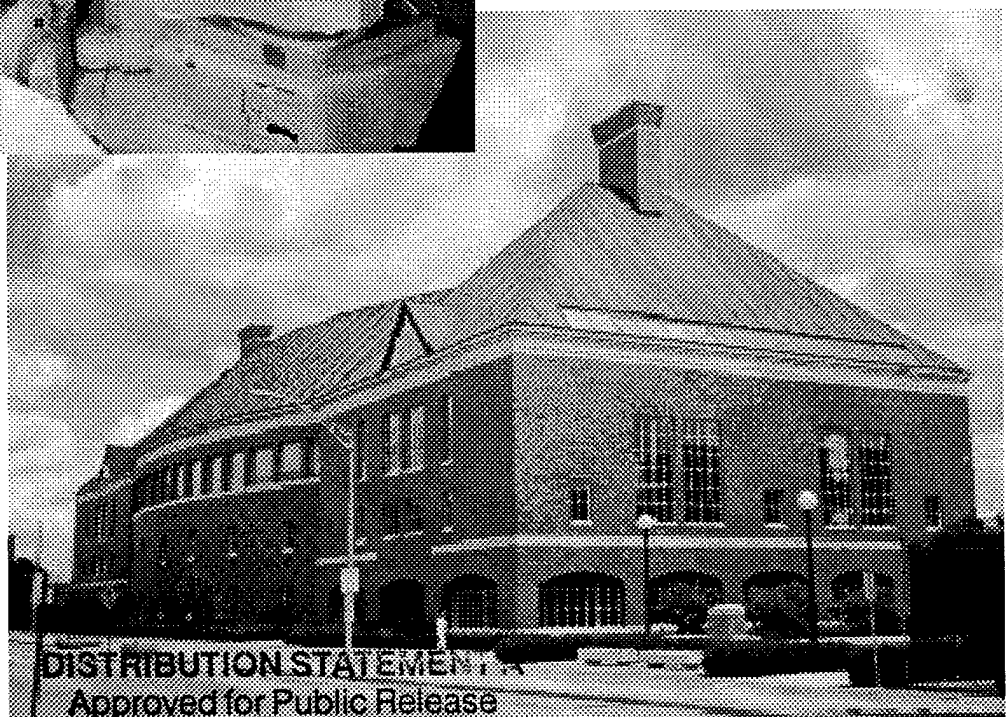
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Construction Engineering  
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**CERL**

FY97 Annual Report

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***On the cover:*** CERL R&D helps the Army sustain realistic training environments for heavy weapons systems such as the M1 Abrams battle tank, which challenges the carrying capacity of installation training ranges. CERL aggressively solicits participation in technology development from the user and proponent communities, as seen in this recent briefing of MG Gill, Commandant of the Army Engineer School. A new educational partnership with North Carolina Agricultural and Technical State University, an HCBU, is one of the many examples of how CERL leverages R&D resources from outside the Army to help solve Army installation-related problems.

## From the Director

---

In FY97, CERL continued our tradition of providing quality products and services to our customers while embracing change that will ensure our relevance to the Army of the future. Technology breakthroughs in smart materials and equipment fragility assessment will help the Army and the nation revitalize the infrastructure. Applied concepts for ecosystem modeling and erosion prediction will enable our Army trainers to make best use of the land while conserving it for future training needs.

The Corps of Engineers Vision and Corps Plus Strategy present exciting opportunities to move forward in partnership with the other laboratories, Districts, and Divisions and truly become "One Door to the Corps." The Vision and Strategy have been easily assimilated at CERL, as many of the concepts and values are already part of our culture: a customer-focused, results-oriented organization; continual business process improvement; virtual, matrixed teams; and corporateness have defined our approach to the business of research and development (R&D) for some time. We have much to offer the Corps in serving as the model for such an organization; we are eager to bring that expertise to bear on the process. The unique synergy among the Corps laboratories will play an important role in achieving the Vision.

The Corps Plus master strategy includes: Revolutionize Effectiveness; Seek Growth Opportunities; and Invest in People. CERL initiated several activities in FY97 that directly relate to this strategy.

- *Revolutionize Effectiveness.* We continued to operate in a business environment with Capability Packages focused on our customers' needs. We completed the first full year of Activity-Based Costing and applied the lessons learned to the current year's operating budget. We developed an FY98 performance plan with four new management objectives and began working on a Customer Support Strategy. The Quarterly Review continued to serve as a forum to assess our fiscal performance and understand the cost of doing business.
- *Seek Growth Opportunities.* We increased efforts at all levels in the laboratories to make customer contacts that clarify needs, both short- and long-term. We are focusing on the leading indicators that will give us the ability to predict what the Army's future R&D needs will be and what resources can be leveraged to serve them. We initiated several activities with Divisions and Districts to strengthen our partnerships, as well as with other partners such as the Army Center for Public Works and Army Environmental Center. We began looking for new opportunities to communicate R&D capabilities to pre-command officers who represent our future leadership.
- *Invest in People.* We continued activities that hold us accountable for customer satisfaction. These include the reimbursable customer satisfaction surveys; In-Progress Reviews; and quarterly reports to Major Commands. Our strong reimbursable program attests to our ability to satisfy our customers, with many of them having had a long-term relationship with CERL. We also invested in our in-house staff, sending several on executive development assignments and having a record number of representatives attend the Emerging Leaders Conference. We renewed the agreement with the University of Illinois to waive tuition for our employees pursuing career-related higher education.

Our success in FY97 will speak for itself in the achievements summarized in this report. We are relevant to the Army in providing the technology edge that enables installations to serve as power projection platforms, a quality place to work and train, and a desirable home to the force.

Michael J. O'Connor  
Director, CERL

## Foreword

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The U.S. Army Construction Engineering Research Laboratories (CERL) FY97 Annual Report was prepared by a team of CERL leaders from the technical laboratories and administrative and technical support offices chaired by Dr. David L. Johnson, Chief, Plans and Programs Office. CERL leadership includes:

Technical Directors:

- Dr. Alan W. Moore, Facilities Acquisition and Revitalization
- William D. Goran, Conservation and Environmental Quality
- Gary W. Schanche, Installation Operations.

Laboratory Operating Chiefs (LOCs) and Division Chiefs:

Land Management Laboratory (LL)

- Dr. William D. Severinghaus, LOC
- Dr. Harold E. Balbach, Chief, Planning and Mission Impact Division (LL-P)
- Robert E. Riggins, Chief, Resource Mitigation and Protection Division (LL-R)

Planning and Management Laboratory (PL)

- Michael Golish, LOC
- Dr. Moonja P. Kim, Chief, Business Processes Division (PL-B)
- Dr. Michael P. Case, Chief, Engineering Processes Division (PL-E)
- L. Jerome Benson, Chief, Environmental Processes Division (PL-N)

Utilities and Industrial Operations Laboratory (UL)

- Dr. John T. Bandy, LOC
- Walter J. Mikucki, Chief, Industrial Operations Division (UL-I) and Acting Chief, Troop Installation Operation Division (UL-T)
- Martin J. Savoie, Chief, Utilities Division (UL-U)

Facilities Technology Laboratory (FL)

- Michael Golish, Acting LOC
- Larry M. Windingland, Chief, Engineering Division (FL-E)
- Dr. Ilker R. Adiguzel, Chief, Materials Science and Technology Division (FL-M)
- Dr. Simon S. Kim, Chief, Maintenance Management and Preservation Division (FL-P).

COL James A. Walter is Commander of USACERL, and Dr. Michael J. O'Connor is Director.

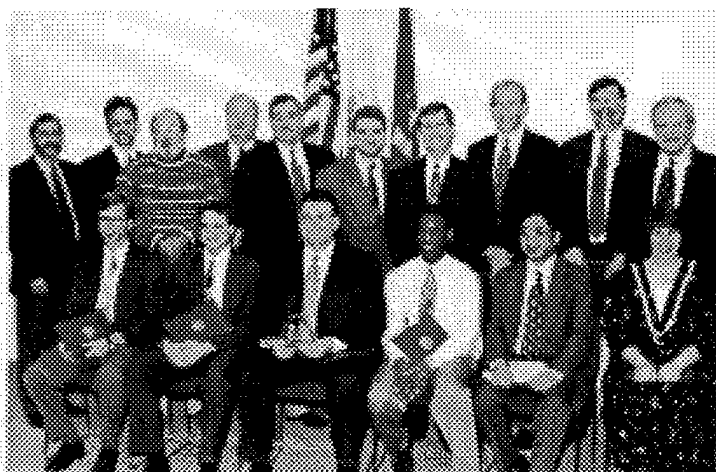
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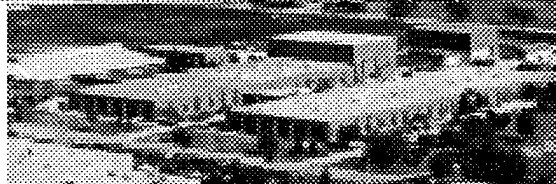
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A 25-member R&D team representing government, industry, and academia received CERL's prestigious Team Award for its work on "Smart Structural Systems," which will improve safety and extend the service life of military and civil works facilities.



## 1 CERL Overview

### ***Mission***

The U.S. Army Construction Engineering Research Laboratories (CERL) is the lead laboratory in the Army for research to support sustainable military installations. CERL's research is directed towards increasing the Army's ability to more efficiently construct, operate, and maintain its installations and ensure environmental quality and safety at a reduced life-cycle cost. Excellent facilities support the Army's training, readiness, mobilization, and sustainability missions. An adequate infrastructure and realistic training lands are critical assets to installations, which serve as platforms to project power worldwide.

CERL works closely with its Army customers to develop quality products and services and to help customers implement new technologies. User groups and steering committees have been established to help CERL identify existing problems, establish research priorities, and provide input into the development of products. Many CERL products developed under this teamwork approach are in daily use, both within the Department of Defense and the private/public sectors. An active technology trans-

fer program ensures these products receive the widest dissemination among prospective users.

### ***Operations and Staff***

CERL's success in providing high quality products is the result of its ability to work with the university community and private industry. CERL was located in Champaign, IL in 1969 to work with the College of Engineering and other organizations at the University of Illinois at Urbana-Champaign.

Over 200 university personnel supplement the 433 government employees at CERL. Its staff represents a wide variety of scientific disciplines ranging from materials engineers to computer programmers to biologists. A multi-talented support staff consisting of technicians, writers, and accountants assists the research staff in the everyday details of conducting research and development (R&D). Under various contract arrangements, CERL actively works with over 40 major universities and private organizations in conducting research to support Army needs.

### ***CERL Business Areas***

CERL conducted a \$77 million R&D program in FY97. The CERL program is divided into



three business areas: Facility Acquisition and Revitalization; Installation Operations; and Conservation and Environmental Quality. The four laboratories within CERL, which execute this program, are the Planning and Management; Utilities and Industrial Operations; Land Management; and Facilities Technology laboratories.

### *Installation Operations*

The intent of this Business Area (BA) is to support Army Directorate of Public Works (DPW) personnel in their duties involved with utilizing, operating, maintaining, repairing, and disposing of the non-industrial and industrial facilities that make up Army installations. Installation Operations R&D is divided into three major research thrusts: improved operations, maintenance and repair (OM&R) technologies, improved environmental stewardship, and improved DPW business practices. The resulting improvements will be achieved through the application of innovative OM&R technologies, the expansion of automation, and the streamlining of DPW business practices. This research supports the vision of the Assistant Chief of Staff for Installation Management's (ACSIM) as described in *Installations: A Strategy for the 21st Century*. The challenge is that these goals must be achieved during a time when financial and manpower resources at installations are decreasing by more than 50% (FY90 to FY00).

### *Conservation and Environmental Quality*

The Army and Department of Defense utilize over 25 million acres of land plus extensive areas of sea and airspace in support of the military training and testing missions. Sustained use of these resources is critical for military readiness, but resource degradation and environmental constraints limit military activities on military lands. The goals of this business area are twofold: (1) to provide knowledge, tools, and improved practices to support the sustained military use of military lands, seas, and air-

space, and (2) to support military stewardship of natural and cultural geophysical resources on these lands. Currently, the business area is organized to deliver a series of major "capabilities" to the military consisting of the following: threatened and endangered species (TES) management, land rehabilitation management, land carrying capacity, military noise management, cultural resources risk assessment, land management technology integration, ecosystems management, and arid lands restoration management.

### *Facility Acquisition and Revitalization (FAR)*

FAR research and development initiatives ensure that the Army has excellent facilities to support training, readiness, mobilization, and sustainability missions. The objective is to develop technologies to significantly reduce installation costs while improving readiness and quality of life. The technologies integrate life-cycle considerations and costs and environmental sustainability concerns into the designed facility. The research is organized into three major thrust areas: (1) facility delivery process improvement, (2) facility seismic risk mitigation, and (3) enduring building systems. The rationale for investment is based on a number of factors unique to the Army: the high cost of Army infrastructure and concomitant migration of funds from readiness accounts to pay for it; unique facilities management problems; a conservative, risk averse, fragmented industry with minimal R&D investment; and public laws and Executive orders.

### *Point of Contact*

The CERL POC is Dr. David L. Johnson in the Plans and Programs Office, COMM 217-373-7205; toll-free 800-USA-CERL; FAX 217-373-7222; CERL, ATTN: CECER-PP, P.O. Box 9005, Champaign, IL 61826-9005; e-mail d-johnson@cecer.army.mil. To learn more about CERL's R&D, visit our home page on the World-Wide Web at <http://www.cecer.army.mil>.

## 2 Accomplishments & Impact Upon Customers

A key purpose of this Annual Report is to communicate CERL's accomplishments and the benefits they have provided to our customers during FY97. The CERL research program is organized around three business areas: Installation Operations, Conservation and Environmental Quality and Facilities Acquisition and Revitalization. Accomplishments are grouped into four main areas:

- Installation Operations
- Conservation and Environmental Quality
- Facilities Acquisition and Revitalization
- Civil Works.

Within each of these main areas, accomplishments fall into the following categories:

1. *Technology Transition.* Achievements that include a transfer of technologies into the field for direct use by our customers.
2. *Breakthroughs.* Research advances in which CERL surmounted a technology hurdle or barrier, or pioneered a technology innovation.
3. *Leveraging.* Accomplishments in which CERL provided special value to customers by leveraging resources from industry, academia, or other outside agencies.
4. *Quick Fixes and Field Assistance.* Achievements in which CERL responded rapidly to a

customer request for assistance and provided a solution to a pressing need.

### *Installation Operations*

The *Installation Operations* business area focuses on improving the efficiency of managing and operating installations while reducing manpower and costs. This business area focuses on energy cost reduction and utility modernization; integrated installation management for maintenance and repair to optimize the use of limited resources; industrial process modernization; and improved business practices. Technology products developed in this business area primarily support the Directorate of Public Works activities at Army and DoD installations.

### *Technology Transition*

**Fuel Cell Demonstration at 30 DoD Sites** [POC: M. Binder] During FY97, installation of phosphoric acid fuel cell (PAFC) power plants was completed at 18 DoD sites, bringing the total number of sites to 30. The 18 sites are estimated to have annual energy savings of over \$1 million and, since NO<sub>x</sub> and SO<sub>x</sub> air emissions are negligible, annual abated emissions compared to conventional power generation are estimated at approximately 55 tons (NO<sub>x</sub>) and 105 tons (SO<sub>x</sub>). However, of possibly even greater value, these PAFC units demonstrate advanced tech-

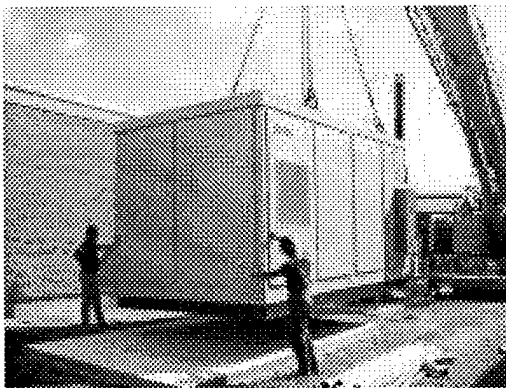
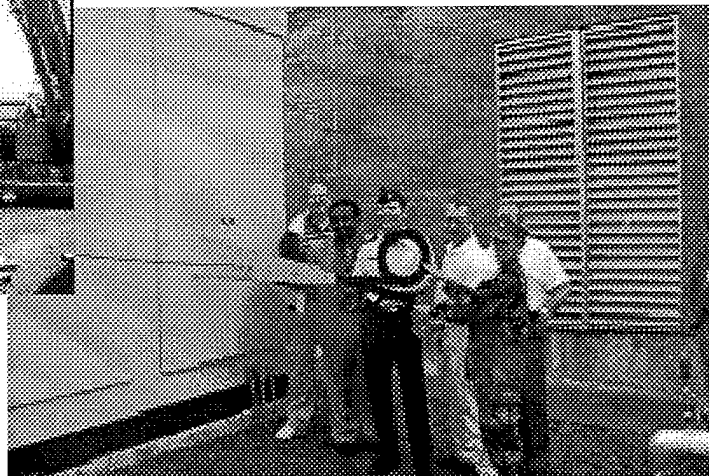


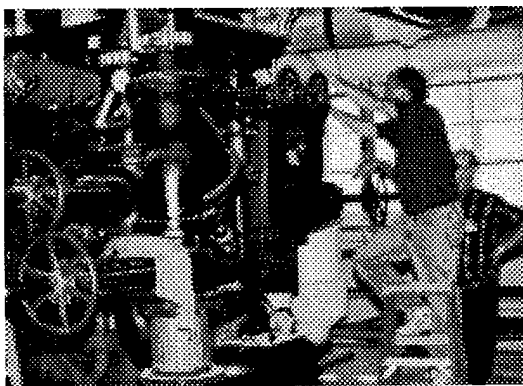
Fig. 1: CERL managed a program involving installation of fuel cells at over 30 DoD sites, such as the one pictured here at Little rock AFB, which gives customers a dual benefit: it saves energy costs and reduces pollution.



nology for operating DoD facilities. This demonstration is also of interest to, and CERL has worked cooperatively with, other agencies and groups working with fuel cell technology: Department of Energy (DOE), U.S. Environmental Protection Agency (EPA), Electric Power Research Institute (EPRI), American Gas Association (AGA), the North American Fuel Cell Owners Group, and the Russian-American Fuel Cell Consortium. In this demonstration, CERL initially screened candidate sites, negotiated contracts for purchase of the fuel cell turn-key package, coordinated design/construction, and monitored performance of installed PAFC units.

**Gas Cooling Demonstrations at DoD Installations** [POC: C. Sohn] In FY97, CERL managed Army and Air Force programs in the \$29M Congressional natural gas cooling demonstration for DoD facilities. Construction and commissioning were completed at Davis-Monthan AFB, Utah Army National Guard (ANG), and Forts Eustis, Dix, and Huachuca. Construction is underway at Warner-Robins AFB, and Forts Bliss and Polk. Selection, design, and contract awards were completed at Hanscom AFB. By the end of 1997, 11 Army installations had 27 units of natural gas cooling systems in operation (including 4 units of desiccant cooling systems); 5 units are under construction at 4 Army installations. The Air Force has 6 units of systems in operation at 4 installations, and 4 units are under construction in 3 USAF installations.

In addition, a REEP study has estimated the annual savings potential to be \$70M by recently developed natural gas cooling technologies at



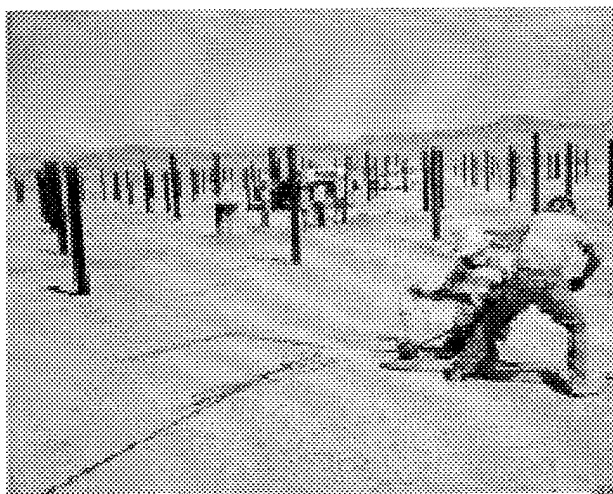
**Fig. 2:** This 300-ton gas cooling unit CERL installed at Fort Riley, KS is part of a \$29M demonstration program for DoD facilities that will help the Army phase out CFC refrigerants while saving utility costs.

DoD facilities. Through the Strategic Environmental Research and Development Program (SERDP) and Federal Energy Management program (FEMP), natural gas cooling systems are operating at 21 DoD installations and under design and construction at 19 installations. CERL will monitor several sites to develop performance criteria, standard design guidance, and commissioning procedures. The project will improve the Army's capability to phase out chlorofluorocarbon (CFC) refrigerants from facility cooling systems and to save utility costs.

**Pentagon Backup Power Facility and Utility Plant Boilers** [POC: D. Herron] CERL assisted Baltimore District and the Pentagon Renovation and Planning Office in determining the feasibility of having the proposed 20-MW diesel generator backup power facility constructed, operated, and maintained through a Model Utility Agreement or an Energy Savings Performance Contract. Using these relatively new contracting mechanisms, either the utility or a contractor would provide all capital and operating costs and recover the investment by operating the powerplant as peak shaving/load-sharing equipment. CERL's analysis and recommendations were based on the assumption that operating the facility in this way would not conflict with the primary mission of reliably supplying emergency backup power to the Pentagon.

A team of engineers assembled by CERL provided technical support for Baltimore District to resolve problems with the commissioning of the Low NOx boilers at the Pentagon Utility Plant. The team of engineers, from CERL, Naval Facilities Engineering Service Center (NFESC), and industry, continues to provide support as needed.

**NMCC Energy Monitoring and Control (EMCS) System Upgrade** [POC: S. Briggs] CERL is providing key technical support to the Pentagon's National Military Command Center (NMCC) as it receives a major upgrade to its EMCS system. This system networks NMCC's UPS system, backup generators, main switch gear, electrical distribution panels, backup chiller, fire alarms, and several heating, ventilation, and air-conditioning (HVAC) systems. These systems are critical to the NMCC mission. CERL provided a condition assessment of



**Fig. 3: CERL enabled several Army installations to augment electrical supplies by developing and implementing photovoltaic power systems like this award winning implementation at Yuma Proving Ground.**



existing systems, and design and scope of work, contract monitoring, and commissioning of the new system. Similar systems have the potential for significant energy savings and productivity gains at many DoD installations.

**Photovoltaic Support to Installations** [POC: R. Ducey] In FY97, CERL continued to assist Army installations with the development and implementation of several photovoltaic power system projects, including: completion of the 900-KVA Photovoltaic Power Station at Yuma Proving Ground, which won a Department of Energy Federal Energy Management Showcase Facility Award; the installation of two 18-kWp, roof-mounted, grid-connected systems at Forts Huachuca and Dix; contractor selection for installing systems that will power pop-up targets on small arms training ranges, helicopter training range track targets, control towers, and airstrip runway lights at Pohakuloa Training Area and Bradshaw Army Airstrip; and 1391 proposal development, submitted to the Energy Conservation Investment Program, for installing a 50-kWp photovoltaic array and battery storage system to augment an existing diesel generator powerplant on the U.S. Army Kwajalein Atoll missile tracking facilities.

#### **Lead Abatement Technology** [POC: V. Hock]

An innovative team of researchers from CERL, the Army Environmental Center (AEC), U.S. Army Center for Public Works (CPW), and the TDJ Group received the Excellence in Technology Transfer Award for 1998 from the Federal Laboratory Consortium. For developing, demonstrating, and validating a technology in which an engineered abrasive (Blastox<sup>®</sup>) is added to a

traditional abrasive medium (i.e., silica sand or coal slag) to create a nonhazardous waste. The waste will not show toxic characteristics for lead and can be disposed as nonhazardous waste at a much lower cost (up to 30% savings on total project costs for potential DoD-wide savings of \$5B). During FY97, CERL concluded both the military and civil works demonstrations of Blastox<sup>®</sup> with the publication of Facilities Engineering Application Program (FEAP) and Construction Productivity Advancement Research (CPAR) reports.

The EPA reviewed and accepted CERL's FEAP report as the definitive work on this type of lead abatement technology. The team was so successful at demonstrating the value of the tech-

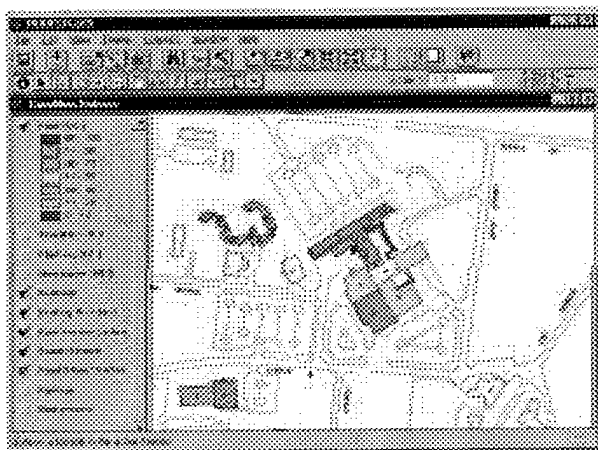


**Fig. 4: Engineered abrasives offer an environmentally friendly and inexpensive solution to the problem of lead paint abatement. Their use can render lead-based paint wastes nonhazardous, reducing disposal costs up to 30%.**

nology for the removal of lead-based paint from wood, steel, concrete, and masonry structures, that the EPA, Federal Highway Association (FHWA), and the SSPC issued favorable position statements, which helped in the acceptance and nationwide use of this technology.

### Micro PAVER Training Video and Manual

[POC: M. Shahin] The Micro PAVER training video and manual were developed as a versatile, standalone training package for new or experienced, military or civilian users of the Micro PAVER system. The training package enables military and civilian users to present in-house training workshops at their convenience and at a reasonable cost. Presented in the 4-hour training video are the most critical concepts of the PAVER pavement management system and the specifics of using the Micro PAVER software package. The training manual serves primarily as a supplement to the video, outlines the topics covered in the video, and gives hardcopies of the figures presented in the video. Produced in conjunction with the American Public Works Association (APWA), the video and manual were completed in FY97 and are currently available for purchase through APWA.



**Fig. 5. ROOFER GIS couples digitized maps to EMS data bases, allowing installation maintenance managers to review entire roof inventories, conditions, and M&R data.**

**ROOFER GIS** [POC: D. Bailey] Spatial representation of ROOFER EMS data is now possible with the FY97 release of ROOFER Geographic Information System (GIS) Version 1.0, which couples ROOFER EMS databases to digitized installation maps through the Environmental Systems Research Institute's (ESRI's) ARCVIEW GIS software. With ROOFER GIS,



**Fig. 6. RAILER EMS eases the reporting burden for track inspectors by reducing overall inspection and compilation time from 40 to 80%.**

the representation of roofing information goes well beyond the typical text and graphic reports generated by ROOFER. The entire roof inventory can be viewed to support M&R decision making. Roof inventory, condition, and M&R data can be displayed in different roofing views; zooming in or out on the installation map can show one or many roofs. A user guide is available through the UIUC ROOFER EMS Support Center.

### RAILER RED Speeds Track Inspection [POC:

D. Uzarski] Railroad track inspection is a laborious task that traditionally involves an inspector walking track and writing inspection findings on paper. This process relies heavily on the inspector's memory of hundreds of possible defects and the later manual compilation of defects into a report. RAILER Remote Entry Database (RAILER RED) improves on this process by using electronic clipboards with defect picklists to streamline the inspection process. Data are quickly uploaded into RAILER EMS for compiling, condition analysis, and M&R planning. Overall, inspection and compilation time have been reduced from 40 to 80%. After extensive field testing in FY97, CERL released RAILER RED Version 3.0 in September. A user guide is available through the University of Illinois, Urbana-Champaign (UIUC) RAILER Engineered Management System (EMS) Support Center.

**Track Structural Analysis for Design and Rehabilitation Work (RACK)** [POC: D. Plotkin] In FY97, Bluegrass Army Depot (BGAD) used

the CERL-developed TRACK computer program for railroad track structural analysis to help select the most cost-effective choices for railroad rehabilitation. TRACK helped reduce the original cost of rehabilitation requirements at that installation from \$17.9 million to \$14 million – a savings of \$3.9 million, or 22%, a result documented in the November 1997 issue of *Public Works Digest*.

**The Environmental Assessment and Management (TEAM) Support to Air Force** [POC: D. Krooks] Teams of CERL personnel assisted Headquarters, U.S. Air Forces, Europe, in conducting environmental compliance assessments at USAFE installations in Italy, Spain, Turkey, Germany, and the United Kingdom in FY97. A new draft compliance assessment manual based on the Final Governing Standards for the given host nation was field tested in each country and modifications to the CERL-developed compliance assessment and tracking software were tested. All products were enhanced as a result of the field tests; each has been finalized and transferred to use in USAFE.

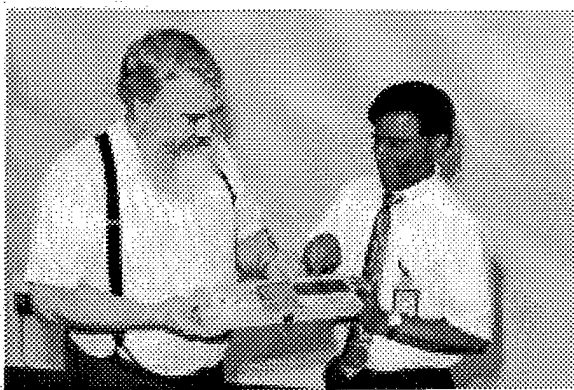
*Leveraging of Industry, Academia, and Other Services or Agencies*

**Wireless Sensing Technologies for Infrastructure Assessment** [POC: W. Croisant] The Army's large inventory of facilities requires regular condition assessment to assure proper performance and the most cost-effective allocation of limited maintenance resources. Wireless sensing technologies offer the potential for remote monitoring without the need for power or wiring at the sensor site. In FY97, the "Wireless Sensing Technologies for Infrastruc-

ture Assessment" Phase I effort was successfully completed with HVS Technologies, Inc., under the Army SBIR Program. This SBIR effort emphasized development of a wireless remote measurement system using surface acoustic wave (SAW) devices. This project contributes to the development of an integrated system to automatically sense, assess, and report conditions of a wide variety of infrastructure components and systems at Army installations, allowing the Army to conduct faster, more reliable, more cost-effective infrastructure condition assessments with a smaller workforce, and reducing long-term infrastructure costs.

**CRADA with EFX** [POC: S. Maloney] The Granular Activated Carbon - Fluidized Bed Reactor (GAC-FBR) was tested for technical proficiency and economic effectiveness in treating de-icing fluids at Albany County Airport, NY, under a CRADA with EFX Systems, Inc. The anaerobic biotreatment process treats synthetic organic chemicals and high strength aqueous wastes in a fluidized bed of GAC. This process can maintain active biomass in the system at up to five times the amount in conventional activated sludge, allowing it to effectively treat wastes more rapidly. The process has been technically effective in treating de-icing fluids, and is one of two finalists in the selection process for implementation at Albany. This technology has been effective in treating propellant production wastewater containing dinitrotoluene (DNT) and is soon to be tested in pinkwater treatment. The process is estimated to be about 50% less expensive than activated carbon adsorption for DNT treatment. After successful feasibility studies, CERL partnered with EFX Systems and AEC for a demonstration at Radford Army Ammunition Plant. CERL has also partnered with the EPA for a demonstration of treatment of chlorinated pesticides in Hungary, in conjunction with EFX and the University of Cincinnati.

**CRADA Between CERL and ESRI** [POC: K. Majerus] CERL established a CRADA with ESRI, a major player in the GIS industry and developer of products such as Arc-Info and ArcView GIS. CERL technical researchers teamed up with ESRI computer programmers to exchange expertise in building prototypes for a GIS data conversion technology. This involved the initial conversion of PRISM, an off-the-shelf



**Fig. 7: Wireless sensing will allow the Army to improve infrastructure assessment at reduced cost.**



(government software) technology, to an ArcView forest ecosystem management module. The converted module links ArcView GIS, database management software, and graphic user interfaces, for use at Fort Polk, LA. This work forms a subset of CERL land management technological innovations that help land managers sustain natural resources and ecosystems as the foundation of the long-term military mission.

**CRADAs with JAYCOR and Text-Trieve** [POC: D. Schell] The Text-trieve CRADA allows for the creation of a searchable CD-ROM version of CERL-developed compliance assessment tools. The TEXT-trieve product will also provide hypertext linking and cross referencing between individual documents. The product is available to the public and to DoD personnel at a subscription fee and provides an enhancement not previously available. The JAYCOR CRADA was undertaken to develop a user-friendly Windows®-based tool designed to quickly collect essential information to meet the needs of Army installation environmental managers and corporate executives. The text of CERL's environmental compliance assessment manual is one tool within this environmental management system.

**CRADAs with Logical and Pacific Environmental Services (PES)** [POC: J. Northrup] Logical and PES commercial off-the-shelf software is being used for environmental management systems. For the software to be useful in the military, reporting features and DoD data dictionary terms must be added. CERL is matching the reporting needs with the database capability. PES and Logical will continue to own their software and will work with CERL to improve the product for the military. Having the Title V forms embedded in these programs is a windfall for PES and Logical in that they can sell it to the public as a program enhancement. Other report fields added are military-specific, but will provide a significant reduction in time for those preparing military reports. Both CRADAs have been approved.

**DOE/Huntington District Partnering** [POC: M. Brewer] CERL is partnering with Huntington District to execute DOE innovative technology projects. The first project is a utility optimization project at Indian Head Naval Surface War-

fare Center, MD. A team from the Corps, Naval Facilities, Naval Sea Systems, the local utility, and a private lab (the Institute of Gas Technology [IGT]) will develop a plan over the next 12 to 18 months to optimize the energy supply and distribution at the facility. Unique opportunities exist as Indian Head has one of the few pulverized coal boiler plants in DoD. The Navy is also interested in exploring innovative ways to dispose of energetic materials with natural gas.

**MEDCOM Reimbursable Program** [POC: D. Hicks] As a research support element to MEDCOM's Center for Technical Expertise (CTX), CERL has coordinated and facilitated a Medical Facilities Manager's training course and a Medical Facilities Manager's Internship. It has also developed a Reliability Centered Maintenance methodology for MEDCOM, implemented a Computer-Aided Facility Management system with links to the legacy maintenance management system at Madigan Army Medical Center (MAMC), and monitored several research- and service-oriented contracts that support the CTX.

Other reimbursable projects underway include implementation of a computerized maintenance management system with the Defense Supply Center, Columbus (Defense Logistics Agency entity) and support to other MEDCOM facilities, Corps of Engineers Districts, and partnerships with private contractors, manufacturers, and vendors.

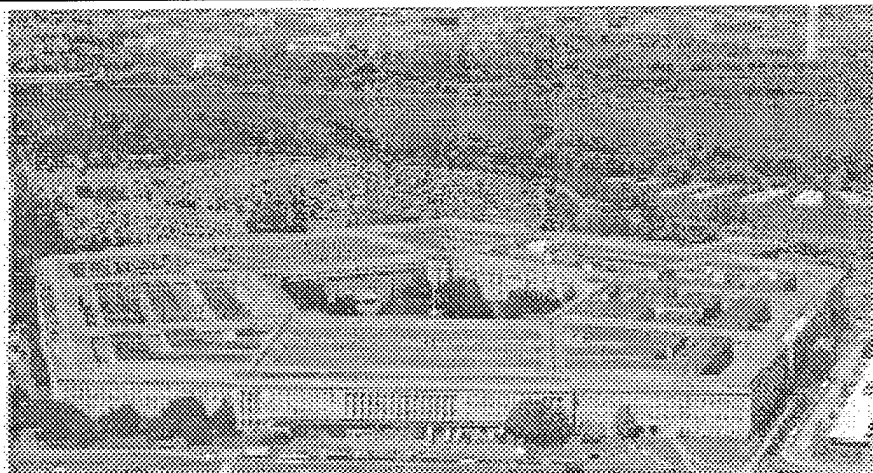
**DOE Energy Base Analysis Code** [POC: L. Lawrie] Energy consumed in U.S. buildings represents 31% of total U.S. energy consumption and accounts for significant levels of greenhouse gas emissions. Two building simulation programs, BLAST and DOE2 (developed at CERL/UIUC and Lawrence Berkeley National Laboratory [LBNL], respectively, over 20 years ago), remain state-of-the-art programs. Memorandum of Agreements (MOAs) between CERL and the EPA and DOE now allow both agencies to take advantage of the more than 20 years of simulation software development to create a product to investigate energy-related pollution factors and pollution prediction.

During FY97, CERL produced a report for the EPA on energy-related pollution factors. In addition, modules were implemented into the BLAST and DOE2 energy analysis programs to illustrate a building's pollution production associated with the combustion of various types of fuel, both on and off site. Calculations can be performed for six different pollutants: CO<sub>2</sub>, SO<sub>2</sub>, NO<sub>x</sub>, CO, hydrocarbons, and particulate matter. With a collaborative effort between DOE and DoD, BLAST and DOE2 are being re-engineered into a new generation program called EnergyPlus, which will reflect the best features of the earlier programs. EnergyPlus represents a significant new product for the building simulation community.

**ASME Boiler Operator Certification Committee** [POC: M. Brewer] This project provides Army representation at the American Society of Mechanical Engineers (ASME) Committee on the Qualification of High Capacity Fossil Fuel Fired Plants and research support for Army issues addressed by the tri-service working group for Boiler Operator Training and Certification. The EPA has also tasked ASME to develop a national certification standard for the States as a result of the Clean Air Act Amendments 1992. A tri-services working group has been meeting ad hoc to research issues arising from the impending national standard. Typically, CERL participates in three to five meetings per year. CERL also has licensed technical instructors and examiners to assist installations. Installations requiring a full training course can obtain those on a reimbursable basis through the CPW Indefinite Delivery Order (IDO) contract. The CERL technical services program leverages CPW in-house resources and is designed to take advantage of CERL's boiler training expertise, and its laboratory and library facilities. CERL is also the DoD member of the main committee.

#### **Lead on DoD TEAM (The Environmental Assessment and Management) Committee**

[POC: D. Schell] During FY97, CERL worked with the U.S. Army Environmental Center, the U.S. Army Reserve Command, the Army National Guard Bureau, the Air Force Center for



**Fig. 8: CERL recommended major changes to the Pentagon's renovation design to reduce the facility's energy system first costs.**

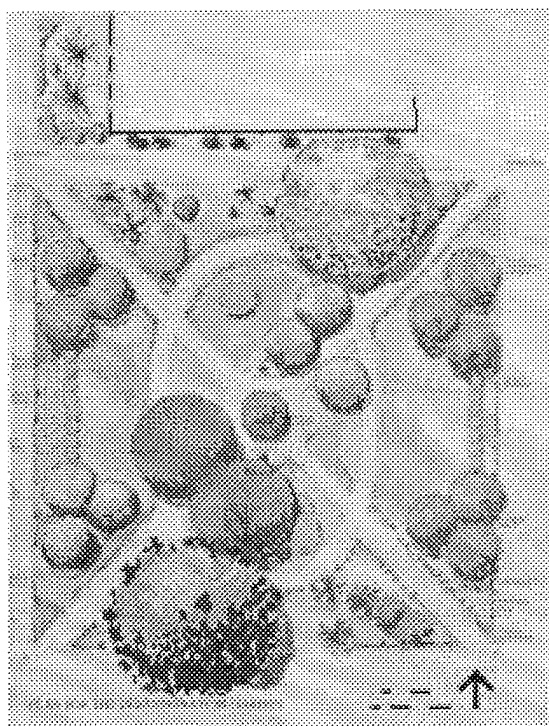
Environmental Excellence, the Air National Guard, the Defense Logistics Agency, and the Corps of Engineers (Civil Works) to coordinate and facilitate the ongoing development of joint-use tools for compliance assessments. Jointly used compliance assessment tools provide a cost savings to all the participants as well as a forum in the TEAM Committee to share information and lessons learned.

#### *Quick Fixes and Field Assistance*

**Assistance with Business Process Improvements at Corps North Atlantic Division (NAD)** [POC: S. Farrel] CERL has been providing assistance to New York District and Norfolk District on business process improvements to support their efforts to revolutionize effectiveness. Each district has done a district-wide internal assessment using the CERL-developed assessment tool based on Army Performance Improvement Criteria (APIC). Additionally, for each district's customers, CERL has done random anonymous telephone surveys. CERL is facilitating improvements in key business processes in their Operations Plans.

**PEPR Increases Productivity at Pine Bluff Arsenal** [POC: J. Northrup] After detailed analyses of its smoke grenade production lines using CERL's Process Energy and Pollution Reduction (PEPR) process, Pine Bluff Arsenal implemented one of the PEPR recommendations and noted a 46% increase in productivity. Pine Bluff has also programmed some of its Defense Basic Operation Fund (DBOF) funding to implement a second PEPR recommendation. The installation Commander voiced great satisfaction with the support provided by CERL.





**Fig. 9:** The garden under construction at Fort Sam Houston (left) demonstrates regionally and historically appropriate plant material and planting techniques for the Fort's historic neighborhoods. The Regional Landscape Management Plan for Fort Bliss (below) was developed to educate residents and land managers in the use of plants and planting techniques consistent with the historic architecture and sensitive to the arid southwest region.



**Pentagon Basement Segment 1 and Wedge 1 Design Review** [POC: D. Herron] During FY97, CERL completed a design review of Basement Segment 1 and Above Ground Wedge 1 of the \$1.2 billion Pentagon renovation project being managed by Baltimore District. Segment 1 and Wedge 1 are the first major portions of the Pentagon building to be renovated. CERL recommended several major changes to the design assumptions used to determine energy system requirements for Segment 1 and Wedge 1. The changes will be incorporated into the remaining design segments of the renovation and should improve the quality of the facility while reducing the energy systems' first cost. In addition, CERL recommended major changes to the chilled water supply system for the renovated Pentagon that will improve the operation of the air conditioning system in the renovated Pentagon.

**HVAC Commissioning Assistance at Fort Monmouth** [POC: D. Herron] As part of BRAC, Fort Monmouth's DPW is performing major renovations of its administration and barracks buildings. In FY97, CERL helped Fort Monmouth establish and train an HVAC Commissioning Team within its Directorate of Public Works (DPW). The team commissioned the HVAC systems in five newly renovated buildings during its training. The in-house HVAC Commissioning Team will ensure that contrac-

tor-installed HVAC systems operate correctly, both improving occupant comfort and productivity, and reducing O&M requirements for these buildings.

**Global Warming** [POC: M. Savoie] CERL served as a technical resource and consultant to a variety of offices in DoD in preparation for U.S. participation in the Kyoto Protocol deliberations on Global Warming. In addition to lending the expertise of CERL researchers, the CERL-developed REEP model was used extensively to estimate potential reductions in greenhouse gases, primarily CO<sub>2</sub>, based on energy reduction at Army and DoD installations.

### ***Conservation and Environmental Quality***

The *Conservation and Environmental Quality* business area recognizes that land is a critical requirement for training soldiers and testing weapons. With each generation of vehicles and weapons systems traveling faster and shooting farther, the available lands for testing and training receive increasingly intensive use. These lands are also the habitat for a variety of threatened and endangered plants and animals and include a variety of cultural resources. Under this business area, CERL is developing tools, technologies, and protocols that support the Army's requirements for environmentally sus-

tainable lands. Many of these technology products are directed for use by the Army training community and land managers.

An enduring aspect of CERL's strategy is its comprehensive partnership with UIUC. This CERL-UIUC partnership may be considered the forerunner to the Defense Science Board's Federated Laboratory concept. Through this partnership, CERL is granted access to state-of-the-art UIUC facilities valued at over \$300 million. UIUC researchers work alongside CERL staff to provide science and technology depth for R&D, technical assistance, and engineering support. CERL also works formally with about three-dozen premier research universities nationwide and many government agencies. Numerous partnerships with the private sector have been developed to conduct research and commercialize technologies to support Army missions.

#### *Technology Transition*

**Historic Landscape Management Plan** [POC: S. Loechl] The Historic Landscape Team, part of the Land Management Laboratory, is developing regional models for historic landscape management. These easy-to-understand illustrative products will be distributed to environmental and planning offices as well as all installation residents living in historic housing areas. The goal is to encourage historically and ecologically appropriate landscaping on Army installations within the particular geographic regions, to reduce landscape and maintenance costs, and to improve the quality of life. Under FY97 funds, the team completed the southwest and mid-Atlantic regional models. The long-term goal is to complete four additional regional models over the next 2 years.

**Metadata Support for USACE** [POC: K. Dilks] A team of researchers from CERL, U.S. Army Cold Regions Research and Engineering Laboratory (CRREL), and the Topographical Engineering Center (TEC) are working to provide tools, scripts, a web server, and training support to USACE Districts for implementation of metadata and data regulations. Users include all U.S. Army Corps of Engineers (USACE) personnel who deal with CADD, GIS, Survey and Mapping, global positioning system (GPS), and other data with global geographic ties. This project supports ER 1110-1-8156 and EC 1130-

2-206 related to the documentation, dissemination, and management of geospatial data by providing training, documentation assistance, and data and metadata server maintenance to ensure USACE compliance with EO 12906.

**Revised Universal Soil Loss Equation** [POC: S. Warren] Accelerated soil erosion results from and ultimately jeopardizes military training and testing. Erosion and sediment models can maximize the effectiveness of erosion control measures by identifying areas of greatest erosion risk and areas of greatest erosion control potential. The Universal Soil Loss Equation (USLE) and its revised version (RUSLE) are the most widely accepted erosion prediction models in the world. However, both equations are one-dimensional and incapable of accounting for complex topography. CERL, in cooperation with the Geographic Modeling and Systems Laboratory at the University of Illinois, has replaced the topographic parameter of the RUSLE with an analog that uses the unit stream power theory and incorporates upstream contributing area.

The improved RUSLE is fully integrated in a geographic information system (GIS) environment. These developments result in a much improved prediction of the spatial distribution of erosion. As a significant added benefit, the equation is now able to predict spatially distributed sediment deposition. The improved equation is available for use in the Army Training and Testing Area Carrying Capacity (ATTACC)



**Fig. 10: Accelerated soil erosion jeopardizes military training and testing. The improved RUSLE is available for use in the Army Training and Testing Area Carrying Capacity model to help installation managers plan and place military training activities.**

model and will be used to assist in the planning and placement of military training activities and land rehabilitation prescriptions.

**TES Survey** [POC: A. Hill] CERL has taken the lead in an ongoing effort to provide the Army with a reliable and timely source of Threatened and Endangered Species (TES) information applicable for a broad range of Army-wide accountability uses. CERL products include an annual TES database that covers TES occurrences and management, TES restrictions and impacts, and points of contact (POCs) for TES information on installations. This database and other CERL products have potential use at all levels of the Army for identifying trends in costs, impacts, and other management issues U.S. Army Major Command (MACOM) wide, as well as hot spots on particular installations. HQDA can get an Army-wide view of the status of TES on all Army lands for reporting to Congress, planning and funding, and setting policy and guidance.

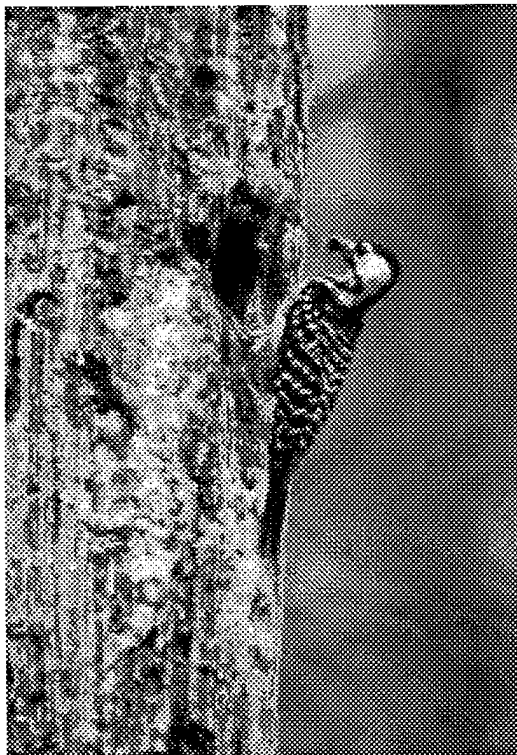
**Cowbird Behavior Model at Fort Hood** [POC: A. Trame] Ecological and computer science experts at CERL teamed up in FY97 to complete a landscape simulation model for Fort

Hood, TX. The Individual Cowbird Behavior Model (ICBM) simulates habitat selection and daily movement of individual female brown-headed cowbirds likely to parasitize nests of breeding endangered species on post. Output from the model can assist endangered species biologists in predicting concentrations of cowbirds, thus improving the efficiency of the installation's cowbird trapping program. The model is transportable to other landscapes in the south-central Great Plains region where cowbird parasitism threatens songbirds.

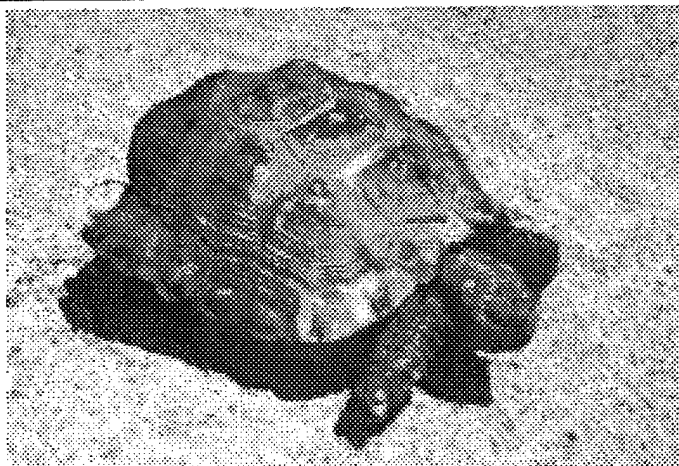
**NAGPRA, Section 3 Implementation at FORSCOM Installations** [POC: L. Whalley] In a continuing effort since FY96, CERL is developing a comprehensive program at all FORSCOM installations that will provide the necessary contacts and decisionmaking resources for compliance with the requirements of Section 3 of the Native American Graves Protection and Repatriation Act (NAGPRA). This section deals with the inadvertent discovery and planned excavation of Native American human remains, funerary objects, sacred objects, and objects of cultural patrimony. These tools will help cultural resources managers verify which Indian tribes are culturally affiliated with the installation area, and in dealing promptly and effectively with the discovery of Native American human remains and cultural objects. Use of these tools will prevent costly delays to training, construction, or archeological mitigation.

### *Breakthroughs*

**Development of ECORAT and Modeling Biodiversity Patterns of the Mojave Desert** [POC: T. Krzysik] Ecological Regional Assessment Technologies (ECORAT) is an ongoing research effort to develop protocols for hierarchical approaches to efficiently and economically characterize, assess, and monitor ecological elements, attributes, and processes at multiple scales and resolutions in a regional context. This work classified the Mojave Desert into ecosystems and associated the entire Mojave fauna (subspecies) with these ecosystems. All faunal elements were also characterized with ecological and biogeographical attributes. The resulting database and analysis represent a major effort for assessing and conserving regional biodiversity in the Mojave Desert. DoD has a vested interest in Mojave natural resources because



**Fig. 11:** CERL's TES data base helps Army land managers maintain training lands while preserving threatened natural resources, like the red-cockaded woodpecker pictured here.



**Fig. 12: CERL's desert tortoise sampling design accurately estimates distribution and density patterns of desert tortoise populations on landscape scales, making it easier for the Army to conduct needed training in areas inhabited by the sensitive species.**

13% of the landscape consists of major military installations representing all four Services.

**Desert Tortoise Characterization** [POC: T. Krzysik] An efficient, economical, and statistically valid sampling design was developed for estimating the distribution and density patterns of desert tortoise populations on landscape scales. The sampling design is highly innovative and represents an important technology because tortoises are very difficult and expensive to survey, particularly over large areas. The design was field-tested at Sand Hill Training Area at the Marine Corps Air Ground Training Area (MCAGCC) and Joshua Tree National Park.

**Automated Bird Call Recognition** [POC: L. Pater] CERL is helping to develop computerized algorithms capable of recognizing and identifying bird vocalizations by species. This technology has application for determining if a particular species is present in a dangerous or remote location. Bird calls are digitized and then analyzed using sophisticated signal-processing techniques. This basic research effort is being executed jointly at two major universities and managed by CERL. FY97 saw significant progress in developing a hybrid call recognition algorithm.

**Vegetation Mapping** [POC: A. Hill] In this first-of-a-kind project, the Army is developing guidelines to help installation land managers map vegetation on their bases. The guidelines, which are considered unique because of the flexibility in meeting different installations' needs, will be used to aid soil, vegetation, and

wildlife conservation and to assist in mission planning. The draft guidelines were developed in a joint effort among the four Army Corps of Engineers laboratories to meet Federal Geographic Data Committee standards. These guidelines are better suited to Army use than the various types of vegetation maps and guidelines developed by other Federal agencies (i.e., the U.S. Forest Service and U.S. Geological Survey), which focus on particular commodities and recommend mapping elements too narrow to meet the Army's needs.

**Geomorphic Process Model** [POC: J. Isaacson] During FY97, CERL and the Department of Civil and Environmental Engineering at Massachusetts Institute of Technology (MIT) have completed the second year of development of the Channel Hillslope Integrated Landscape Development Model (CHILD). Significant advances in the model include the linking of hillslope processes with fluvial processes in an adaptive irregular mesh, which allows sediment transport to occur at different spatial scales across the landscape. Additionally, a lateral erosion, river meander module has been integrated into CHILD. The module simulates fluvial response to hillslope erosion processes.

#### *Leveraging of Industry, Academia, and Other Services or Agencies*

**Helicopter Noise and Mexican Spotted Owls** [POC: L. Pater] The Endangered Species Act requires Federal Agencies to preserve threatened and endangered species present on agency lands. Because of potential impacts on an endangered species, the Mexican Spotted Owl (*Strix occidentalis lucida*), a USAF search and



**Fig. 13: Automated bird call recognition will help identify and locate endangered species in remote locations, and promises to simplify the task of complying with environmental guidelines.**

**Fig. 14: CERL helped determine the extent of the impact of helicopter overflights on the Mexican Spotted Owl to obtain less restrictive management guidelines.**



rescue helicopter squadron was constrained from making training flights over a mountainous wooded national park for more than 6 months of the year. Completed in FY97, this project de-

termined the extent of the impact of helicopter overflights on spotted owls. The data will support consultation with regulators to obtain less restrictive management guidelines. This project was jointly executed by CERL (helicopter noise expertise), USAF, and U.S. Forest Service.

#### **Joint Programs Land Management System**

[POC: B. Goran] During 1997, the Corps of Engineers laboratories initiated a new project focused on the development of a new capability for land management decision support. This initiative, entitled Land Management System (LMS) is being designed to provide improved modeling, simulation and data analysis capabilities for land management requirements on all of DoD lands, both military installations and civil works reservoirs and waterways. LMS is an effort involving all four Corps laboratories (and other Corps elements), with CERL and WES sharing leadership responsibilities. Demonstration projects are underway in Central Texas (Fort Hood, Belton Reservoir) and at three locations in the Upper Mississippi River System (Pool 8, near LaCrosse, WI, near the confluence of the Minnesota and Mississippi Rivers, and on Peoria Lake near Peoria, IL (along the Illinois River).



#### **Dynamic Landscape Modeling Links Land Stewardship and the Military Mission** [POC: K. Majerus]

The CERL Land Management Laboratory, in partnership with the DOE and Argonne National Laboratory, have developed a dynamic landscape-modeling approach to sustain natural resources as the foundation of military activities. Funded by SERDP, this initiative created a the

Integrated Dynamic Landscape Analysis and Modeling System (IDLAMS). The IDLAMS computer system links ecological models, land management alternatives and costs, decision-support techniques, and a GIS using remote sensing and field inventory data. The current test site is Fort Riley, KS. The user-friendly IDLAMS computer interface allows land managers to operate this predictive, decisionmaking planning tool without a need for substantial computer or environmental modeling expertise. IDLAMS is an integrated predictive modeling approach and a promising dual-use technology that supports the Army's primary mission with increasingly limited funding.

#### **Ecological Dynamics Simulation (EDYS) Model**

[POC: D. Price] CERL and the University of Texas at El Paso have developed an application of the EDYS model to support Army installations and other Federal agencies. The model will allow land and training managers to take a sound ecological approach to land use and management decisionmaking. During the last year, the results of the development of the EDYS model for the five installations have become visible. The National Park Service has invested \$680K over the next 4 years to parameterize and apply the model to six major national parks. In addition to the Park Service investment, the USDA Natural Resources Conservation Service (NRCS) and the Air Force Academy in Colorado have invested in CERL's effort for applications of the model to their lands in 1998. The U.S. Fish and Wildlife Service, the Bureau of Land Management, and the EPA, are also interested in the model's potential as a tool to manage TES habitat, restoration efforts, and risk assessment.





**Fig. 15: CERL's Archeological Laboratory anticipates customer support by accommodating at least two concurrent field archeological investigation projects**

Because CERL is proactively supporting Research and Development (R&D) for land management tools and technologies, the Army is in an excellent position to influence what standards and tools will be adopted by public land management agencies and how the regulators will develop and apply current and future regulations.

**Illinois EPA Regional Partnerships** [POC: D. Curtin] During FY97, CERL and Illinois government agencies and local communities formed the DoD/IL EPA Pollution Prevention Partnership. This partnership is an effort to create a working relationship with government agencies and local communities to promote and implement pollution prevention as the preferred strategy for protecting the environment, conserving resources, fostering community well-being, and enhancing mission readiness at DoD installations in Illinois. By working with this partnership and by contacting similar DoD/EPA regional partnerships developing nationwide, CERL will be uniquely positioned to facilitate the flow of information nationwide.

#### *Quick Fixes and Field Assistance*

**Archeological Laboratory** [POC: S. Doggett] The Tri-Service Cultural Resources Research Center (CRRC) centrally organized Archeological Laboratory contains field and laboratory equipment and supplies, archeological collections, and project reports. The laboratory is designed to accommodate all anticipated needs of at least two concurrent field archeological investigation projects, including secure storage of field-collected, but unexamined specimens,

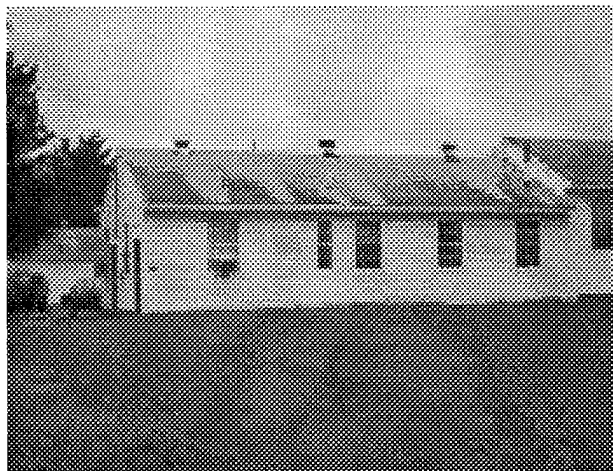
and a separate artifact storage center that conforms to the environmental and security regulations stated in 36 CFR Part 79.

#### **Conservation Assistance Program (CAP)**

[POC: B. Lacey] CAP provides rapid, "hands-on" technical assistance and technology application for field problems associated with natural and cultural resources on Army lands. CAP technical assistance can be multidisciplinary, and can be obtained at no cost to the requesting Army installation. During FY97, CERL completed or initiated installation support on 10 CAP requests. Of these 10 requests, five dealt with survey and analysis species data, including threatened and endangered species. This support was provided to Fort Hood, Camp Grayling, Fort Wingate Depot, Fort Pickett, and the U.S. Military Academy (USMA). Other efforts included assessment of building requirements for an archeological/ curation facility at Fort Campbell; support for development of a fire management plan and contract at USMA; guidance on dust control at Fort Leonard Wood; geographic information system database conversion assistance for Fort Bliss; and development of forest management data and database for Fort Pickett.

#### **Intense Use Training Sites** [POC: M. Sharif]

Intensely used training sites such as drop zones, assembly areas, bivouac areas, firing points, and tank trails commonly require frequent maintenance and repair. Improved technology can generate significant life-cycle cost savings when applied to such sites. For example, tests of



**Fig. 16: Under the CAP program, CERL successfully conducted an adaptive reuse study of a temporary World War II structure (Bldg. 2159) to provide the quality collection storage needed to establish a Curation Facility at Fort Campbell.**

subgrade stabilization at firing points using rubber blocks made from recycled tires reduced annual maintenance requirements by 75%. Testing showed the cost of alternate methods for repairing highly eroded areas of drop zones to be one-seventh the cost of conventional methods. These and other improved technologies help sustain land for combat training.

**HABS Documentation in Panama** [POC: J. Webster] Under the terms of the Panama Canal Treaty of 1977, the United States will relinquish control of the former Panama Canal Zone and all U.S. military bases and installations located in Panama to the Panamanian government by 31 December 1999. As part of treaty implementation, CERL has provided multi-service cultural resource assistance to bases in Panama. Because cultural resource compliance involving the turnover of U.S. military facilities in Panama does not fall under provisions of Base Realignment and Closure (BRAC) or the Canal Treaty, CERL established new methods, in keeping with the Overseas Environmental Baseline Guidance Document, which may also prove useful to other overseas bases as they come under BRAC.

**Ecological Assessment at Fort Pickett** [A. Hill] Fort Pickett finds itself in a unique position of simultaneously transferring MACOMs (to the National Guard Bureau) and initiating preliminary plans for building a proposed Multipurpose Range Complex. To help the installation preserve the local ecosystem, CERL conducted field work to assess a rare plant species (*Rhus michauxii*). Two technical reports were produced to support the MACOM change and building plans; one focused on density estimates, the other on an assessment of Fort Pickett's ecology and the composition of the plant community. CERL will make a presentation to the Association for Southeastern Biologists and follow up with a peer review article.

### ***Facilities Acquisition and Revitalization (FAR)***

The *Facilities Acquisition and Revitalization* business area provides for the research, development, and delivery of capabilities in design, materials, and delivery of facilities. As one of the largest owners of built facilities, the Army must ensure that its facilities are cost-effective,

durable, environmentally sustainable, and flexible enough to support changing missions and to serve as the platforms for military power projection. Many of the technology products CERL helps develop will help the Corps provide quality and affordable mission-responsive facilities to both the Army and Air Force.

### ***Technology Transition***

#### **Development and Demonstration of Advanced Design Composite Structural Components**

[POC: R. Lampo] This CPAR venture with West Virginia University (WVU) developed a lightweight composite bridge deck (H-deck) system that met AASHTO HS25 truck live-load criteria for stringer spacing up to a maximum 9-ft span. Working with WVU, the West Virginia Department of Transportation (DOT) constructed two short-span demonstration bridges during FY97 using the H-deck system. A cost-benefit analysis of the H-deck system indicated that the as-constructed cost of the deck system is slightly higher than that of traditional reinforced concrete decks, but composite decks show a significant life-cycle cost advantage over conventional reinforced concrete decks, which have a corrosion problem with the reinforcing steel in the conventional concrete deck. In rehab and replacement, the prefabricated H-deck components will minimize the downtime needed for deck replacement. This project was one of five 1997 nominees for the Civil Engineering Research Foundation (CERF) Charles Pankow Award for Civil Engineering Research.

**EPA Approval for FURY** [POC: C. Marsh] In FY97, CERL continued to introduce FURY, an innovative condition inspection/assessment system for underground storage tanks (USTs). FURY decreases the cost of assessment before upgrade with cathodic protection by more than 50% and also promotes the continued safe use of existing USTs. The expense of replacement is avoided while a dramatically improved reliability associated with condition assessment is obtained. On the technical front, the advanced prototype robotic system was adapted and improved for service while immersed in non-POL liquids. Required testing of the improved system in fresh water was carried out successfully. Third-party evaluation of the system has gained EPA notice and acceptance. CERL is working closely with AEC to deploy FURY DoD-wide.

Many other potential applications identified include assessment of civil works structures such as sheet pile and outflow pipes.

**Modular Design System (MDS) 2.0** [POC: E. Griffith] Version 2.0 of MDS was finalized for delivery on 8 October 1997. Under the terms of the Corps' Cooperative Research and Development Agreement (CRADA), the commercial partners will add documentation, produce a new CD-ROM, and ship a commercial version of MDS during 1QFY98. MDS will be available as commercial off-the-shelf software and the government will receive royalties on sales to the commercial sector. Architect/Engineer (A/E) firms that have used MDS on Army Reserve projects have requested permission to use MDS on non-DoD projects, demonstrating the flexibility of the software.

**Micro PAVER 4.0 for Windows** [POC: M. Shatin] Having proven itself an effective tool for pavement management of both military and civilian roadways and airfields, the Micro PAVER software package needed an overhaul to keep pace with current operating system trends. Released in March 1997, Micro PAVER 4.0 for Windows was the first version of the software that could operate fully within the Windows environment. The next step in the evolution of the Micro PAVER software package, version 4.0 is significantly easier to use and offers users the standard benefits of Windows-based programs. Development of Micro PAVER 4.0 for Windows was funded by the Federal Aviation Administration; Federal Highway Administration; U.S. Air Force Engineering and Services Center; U.S. Army Corps of Engineers, and the U.S. Navy.

*Leveraging of Industry, Academia, and Other Services or Agencies*

**Seismic Testing of Advanced Materials** [POC: G. Al-Chaar] CERL and the Tennessee Valley Authority (TVA) performed seismic analysis and shake table seismic testing of unreinforced masonry bearing and shear wall specimen. This joint CERL/TVA effort is investigating new and innovative ways to enhance the seismic resistance of damaged unreinforced masonry bearing and shear walls. The specimen consists of two parallel walls connected by a concrete slab. One wall was protected with a composite overlay material, the other was an unprotected plain

masonry wall. Tri-axial time history tests were performed using the time history records generated to fit Tennessee Valley-wide design response spectra.

**Seismic Vulnerable Facilities Database** [POC: S. Sweeney] CERL is working in partnership with the Corps of Engineers Seismic Technical Center of Expertise (TCX) to satisfy Executive Order 12941, which requires Federal agencies to assess the seismic vulnerability of all buildings and estimate the cost to mitigate the risk. CERL has compiled a database of Army buildings and has performed analysis based on established Federal criteria and expertise on the performance of buildings in past earthquakes. Potentially vulnerable buildings are being evaluated through the Seismic TCX. CERL is using the results to improve seismic performance prediction and mitigation cost estimation.

**Critical Equipment Fragility and Protection Procedure (CEFAPP)** [POC: J. Wilcok] This research developed guidance for defining the vulnerability and methods of protecting mission-critical equipment, such as hospital radiology equipment. CEFAPP defines the capacity of critical equipment using shake table testing. Equipment design spectra from predicted building motions is laid over the capacity spectrum to define equipment vulnerability and guide methods of protection. CERL completed the development of CEFAPP in FY97 and demonstrated it in the fragility testing of a large power transformer bushing. CERL partnered with the TVA and the Institute of Electrical and Electronics Engineers (IEEE) in the testing of the bushing.

Equipment manufacturers can use CEFAPP to define the capacity of critical equipment, and the results can be published in product literature. DoD equipment procurement offices can specify that critical equipment meet the seismic design spectra for a particular location based on the guidance in CEFAPP. Application of CEFAPP to the evaluation and protection of critical equipment will greatly enhance mission readiness and protect expensive equipment.

**CERL Helps University Win Midwest Quake Center** [POC: J. Hayes] In September 1997, the National Science Foundation (NSF) awarded a 5-year research grant to the University of Illinois at Urbana-Champaign for research on



mitigating the effects of large magnitude, infrequent earthquakes in the central United States. The U of I leads a consortium of universities in this venture, known as the Mid-America Earthquake Center (MAEC). Other university participants are Georgia Institute of Technology, Massachusetts Institute of Technology, Texas A&M University, Washington University, St. Louis University, and Memphis State University. The MAEC is one of three regional earthquake centers to receive NSF support. Many of the research needs that MAEC addresses parallel those found in CERL's seismic research program, providing significant opportunities for leveraging our research funds. Some MAEC projects may use CERL facilities, e.g., the Tri-axial Earthquake and Shock Simulator (TESS).

#### **CERL SBIR Partner Wins Composites Award**

[POC: R. Lampo] A CERL partner in composites research, Kansas Structural Composites, Inc. (KSCI), received an international award for the greatest contributions to the composites industry in 1996. KSCI worked with CERL under the Small Business Innovation Research (SBIR) program and with additional funding from the Transportation Research Board, to design and build an all-composite bridge over No-Name Creek in Russell, KS, the first to be installed in the United States. KSCI received the award from the Composites Institute in recognition of this accomplishment.

#### **Digital Hardhat System** [POC: A. Stumpf]

CERL has partnered with UIUC to field test the Digital Hardhat at Fort Worth District. This technology addresses the problem of collecting and organizing multimedia project data (images, video, text, and voice) and enables real-time collaboration between team members at remote sites and field offices. UIUC developed Multimedia Reporting System (MRS) with the Digital Hardhat so that several International Construction companies can collaborate overseas on large construction projects. MRS allows the field representative to capture and save multimedia information into a project-specific database, which is then accessible to others through the World Wide Web (WWW). The pen-based computer can also be used to communicate between the remote site and other locations using a direct network connection, a wireless network connection, ISDN (Integrated Services



**Fig. 17: CERL field tested the Digital Hardhat system at Fort Worth. The system enables real-time collaboration between team members and field offices to quickly share information, solve problems, and prevent construction delays.**

Digital Network) line, or modem. Several communication configurations allow the mobile user to roam around the site and share high resolution images with others to solve problems collaboratively. Immediate reductions in travel cost will be the most obvious benefit. However, lower costs from more quickly resolved issues, reduced construction claims, and fewer delays will be the ultimate benefit of this technology.

#### **DrChecks and the OKBank** [POC: B. East]

The ability to retrieve, evaluate, and adapt past experience to current problems is one of the hallmarks of a learning organization. Past attempts to develop organizational systems to capture so-called "lessons learned" have failed due to the high cost of operating and administering such systems. CERL has developed (in collaboration with Corps Districts, private construction firms, public agencies, and academic interactions) two demonstration systems designed to easily integrate the capture of organizational knowledge into current business practices. This integration drastically reduces the overhead associated with capturing critical corporate knowledge and virtually eliminates the need for new stand-alone computer systems, training, etc. Organizational knowledge has been defined as a result of this research as the combination of "success stories," "good work practices," and "lessons learned" that have been captured in such a way to be meaningful for those who may need to access the information at a later time.

Both systems use the communications provided via the world wide web to provide a restricted access collaborative site. The Military Programs focused product is called the Design Review and Checking System (DrChecks). DrChecks is awaiting final approval to be tested at selected Corps sites and is being commercialized through Bently Microsystems, Inc. The Civil Works focused system is called the Organizational Knowledge Bank (OKBank). The OKBank was developed during FY97 in collaboration with the Vicksburg District.

**Environmental Knowledge Base For Facility Sustainability (EnvKB)** [POC: T. Napier] CERL and the EPA collaborated with Stottler Henke Associates Inc. (SHAI, CERL's SBIR contractor) to develop EnvKB, a PC-based advisor system that provides data about resource depletion, energy use, occupants' exposure to emissions and contaminants, waste, recycling considerations, and other environmental effects. EnvKB interfaces with other computer programs for energy analysis, indoor air quality analysis, and cost estimating. EnvKB will be used primarily by architects and engineers engaged in design services for USACE projects. SHAI has concluded arrangements with Environmental Building News and the Center for Renewable Energy and Sustainable Technology to distribute to the commercial market. Direct benefits of using EnvKB include reducing adverse environmental impacts and improved life cycle performance. Conservative estimates indicate cost avoidance of \$100s of millions annually from improved occupant productivity, health care avoidance, energy savings, reduction of water use, and reduction of atmospheric emissions.

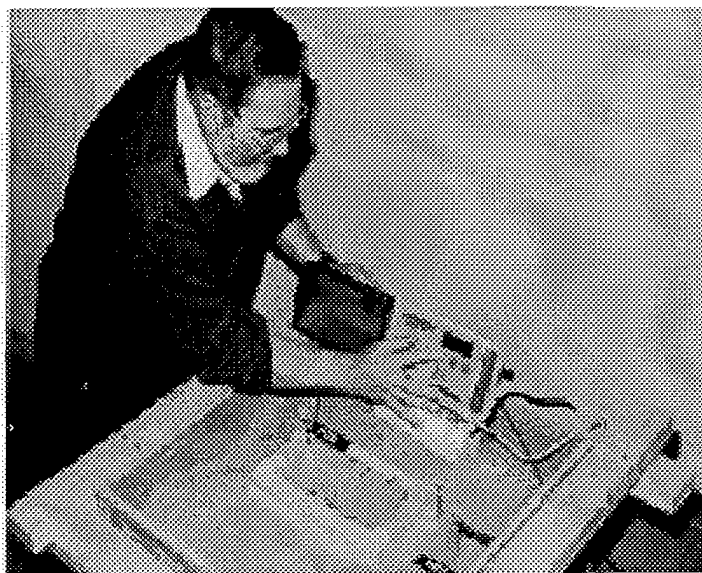
#### *Quick Fixes and Field Assistance*

**Electro-Osmotic Pulse Technology** [POC: V. Hock] CERL has been aggressively helping DPWs implement Electro-Osmotic Pulse (EOP) technology to prevent water seepage into buildings, which results in structural damage, corrosion, and poor air quality. CERL, the University of Wisconsin, and Drytronic, Inc. worked with the Center for Public Works and the DPW to apply this technology to a building at Fort Jackson, SC. The application at Fort Jackson reduced costs by 40% in comparison with conventional

methods. In addition to Fort Jackson, the technology has been installed in various buildings at Fort Monmouth, Tobyhanna Army Depot, McAlester Army Ammunition Plant, and the U.S. Army Tank Command. Recently CERL and Drytronic entered into a partnership agreement to enhance the technology using the CERL-developed ceramic anode.

**Paint Consulting** [A. Beitelman] The Corps of Engineers Paint Technology Center—located at CERL—provides a wide range of support to the Corps in all matters relating to paint, protective coating, and other methods of mitigating corrosion for Civil Works and military construction and maintenance. In FY97, the center responded to over 500 telephone consulting calls from Corps districts, other government agencies, and private industry. CERL provided on-site failure analysis to several districts and participated as expert witnesses in legal cases, all of which lead to equitable court settlements. Other CERL-provided field support included testing paint samples for compliance with contract specifications, conducting schools, and providing technical support to OCE for updating guide specifications, technical manuals, and other criteria documents within assigned areas.

**GN/CC at West Point** [POC: B. Deal] The new Grey Ghost family housing project at the U.S. Military Academy at West Point represented a unique opportunity for the implementation of



**Fig. 18: EOP technology, modeled here by a CERL researcher, prevents basement water seepage. CERL implemented the technology at Fort Jackson at a cost 40% lower than conventional methods.**

the CERL-developed Green Neighborhood/Cool Communities process (GN/CC). GN/CC is a prototype for constructing family housing neighborhoods that meet the daily needs of the military family while minimizing negative environmental impacts, reducing the general energy consumption of the facilities, and improving the overall quality of life of resident personnel and their families. The overall goal of the process is to provide cost competitive housing that is a more easily maintained and sustainable product.

**Structural Health Monitoring and Repair of Unreinforced Masonry Walls** [POC: R. Quatrone] Many of the 2400 barracks in the Army's inventory consist of buildings using unreinforced masonry (URM) structures. Many of these barracks require upgrades to meet new seismic codes or to repair aging structures. Upgrading by conventional techniques can cost as much as \$50 per sq ft.

Working with a virtual team of industry and academia under a matching funds CRADA, the CERL-led team developed and demonstrated an alternate URM wall upgrade technique using "smart" composites. The low cost fiber-reinforced polymer composite contains health monitoring capability. It offers a potential for a significantly lower cost alternative to achieving the increased structural safety while providing

on-demand damage detection capability. The composite upgrades increased the load carrying capability of URM walls by 45 to 94%. The sensors were found capable of sensing the presence and location of damage in the overloaded URM walls before the damage became critical. Such a capability could improve safety and extend the service life of the Nation's defense and civil infrastructure.

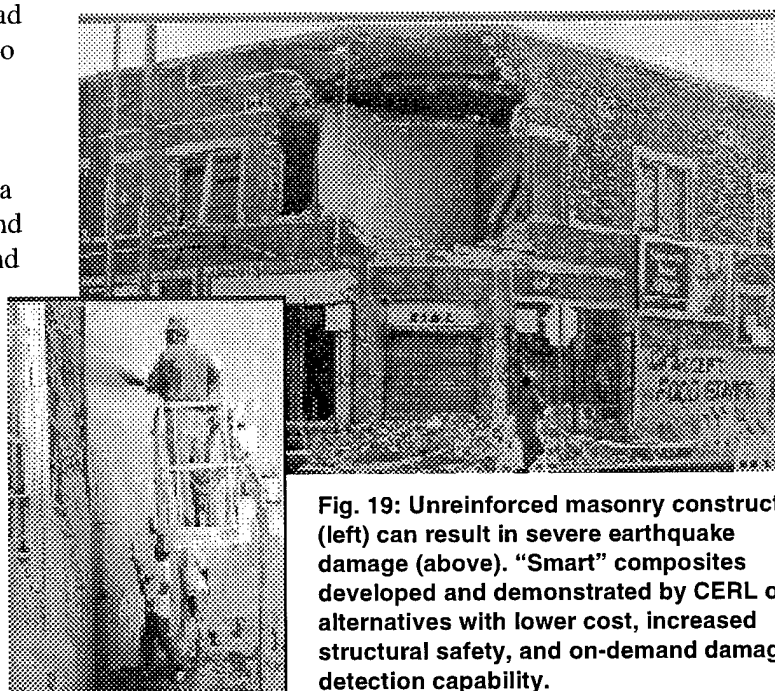
### Civil Works

**BREAKWATER Approved for Release** [POC: D. McKay] The initial version of the Coastal Structure Management System computer program, BREAKWATER, has been approved for Corps-wide release by Headquarters, U.S. Army Corp of Engineers (HQ, USACE). Produced as part of the Civil Works REMR

program, the program is being distributed to all USACE coastal Divisions and Districts, under cover letter from Charles Hess, Chief/CECW-O. The program is designed for keeping an inventory of coastal structures and their characteristics, collecting condition inspection, calculating both physical and performance index values and producing summary reports.

**RAMS II Planning Document for Civil Works** [POC: P. Loechl] The regulatory division of the Corps of Engineers processes about 13,000 permits annually for water-related activities under its authority. The input, management, analysis, and reporting of regulatory data have traditionally been carried out with district-unique software and database designs. These disparate systems have resulted in high corporate costs for system development, procurement, training, and support, as well as the reduction of the reliability and accuracy of upward data reporting.

The Regulatory Analysis and Management System (RAMS II) is an updated corporate automated information system (AIS) that CERL has developed and tested at nine districts with HQUSACE. RAMS II addresses deficiencies with district-specific systems by standardizing and normalizing the database structure and porting the system to compliant software within Army Technical Architecture guidelines.



**Fig. 19: Unreinforced masonry construction (left) can result in severe earthquake damage (above). "Smart" composites developed and demonstrated by CERL offer alternatives with lower cost, increased structural safety, and on-demand damage detection capability.**



**Fig. 20: CERL's BREAKWATER program keeps an inventory of coastal structures and their characteristics, collects condition inspection, calculates both physical and performance index values, and produces summary reports. The software is approved for release to all USACE coastal Divisions and Districts.**

CERL has produced required Life Cycle Management of Information Systems (LCMIS) planning documents for RAMS II through the testing and evaluation phase. LCMIS documentation will allow HQUSACE to request approval for deployment of RAMS II at a Corps Major Automated Information System Review Council in FY98.

## 3 Resources To Serve Customers

### ***Educational Profile***

CERL continues to maintain a highly educated professional work force. Over 14% (31) of the professional staff have a Ph.D., 52 % (115) have at least one Masters degree and 33% (73) have a Bachelors degree. Seven employees received a masters in 1997. CERL has nine licensed Architects, 25 registered or certified professional engineers, and seven professionals registered in other fields.

### ***Professional Development***

CERL places a high value on employee education and continuous development encouraging continuing education for all employees. The lab sponsors two highly coveted awards each year, the Year of Advanced Study (for technical professionals) and the Semester of Advanced Study (for support personnel). Eight CERL employees are candidates in masters programs and 14 CERL employees are working for their doctorates. Degree programs include mechanical engineering, electrical engineering, engineering management, and computer science. CERL employees took more than 24 graduate level courses last year. Institutions selected by CERL employees for their degree programs include University of Illinois, University of Massachusetts, and Auburn University.

CERL Researchers held 14 Adjunct professorships at the University of Illinois and served on 9 Masters committees and 4 Ph.D. committees.

### ***Professional Recognition — Patents, Papers, Citations and Other Achievements***

In FY97, CERL researchers published a total of 37 papers in refereed journals and 79 technical papers in conference proceedings. A total of 47 abstracts were submitted for publication.

### ***Professional Recognition — Honors, Presentations and Image Among Peers***

CERL employees are active participants in a variety of professional activities. They chaired over 21 committees and task groups on behalf of professional organizations. Highlights of some of these and other FY97 activities are presented below:

- Mr. Vincent Hock, Mr. Michael McNerney, and Dr. Aaron Averbuch received Letters of Appreciation from the Honorable Tommy G. Thompson, Governor of Wisconsin, and LTG Joe N. Ballard, Chief of Engineers for their work on validating the electro-osmotic pulse (EOP) technology.
- Dr. Anthony Krzysik was appointed "Section Editor for Statistics and Experimental Design" and "Editorial Review Board" for the International Journal: *Amphibian and Reptile Conservation*.
- Dr. Paul Schomer delivered an invited plenary lecture (keynote address) to a meeting in The Hague, Netherlands, of about 200 European scientists and regulators dealing with Harmonized Noise Measures as a part of efforts to create a unified noise policy.
- An article entitled "Controlling Dust on Unpaved Roads," based on an interview with Dick Gebhart and conducted by Charles Bader, Staff Writer, appeared in the July/August edition of *Erosion Control*.
- Dr. Ed Smith has been officially appointed to the Editorial Board of the *International Journal of Environmental Engineering and Policy*.
- Dr. Julian Palmore chaired a national meeting on Warfare Analysis and Complexity at the Johns Hopkins University, 15-17 September, in Maryland, sponsored by the

Military Operations Research Society, Alexandria, VA.

- Dr. Paul Schomer was elected vice president for membership in the Institute of Noise Control Engineering.
- CERL was notified by the American Ceramic Society that the paper on Thermal Spray Vitrification Process published in the *Environmental Issues and Waste Management Technologies* won the 1996 Best Paper Award. The paper was authored by Dr. Ashok Kumar, Jeffrey Boy, and Lake Latimore.
- Mr. Tim Race was appointed the General Seminars Co-Chair for the Steel Structures Painting Council 1997 International Conference and Exhibition, San Diego, CA.
- Mr. Martin Savoie received a certificate of appreciation from Paul W. Johnson, Deputy Assistant Secretary of the Army (Installations and Housing) for supporting the Army's initiative to privatize family housing.

### ***CERL State-of-the-Art Equipment and Facilities***

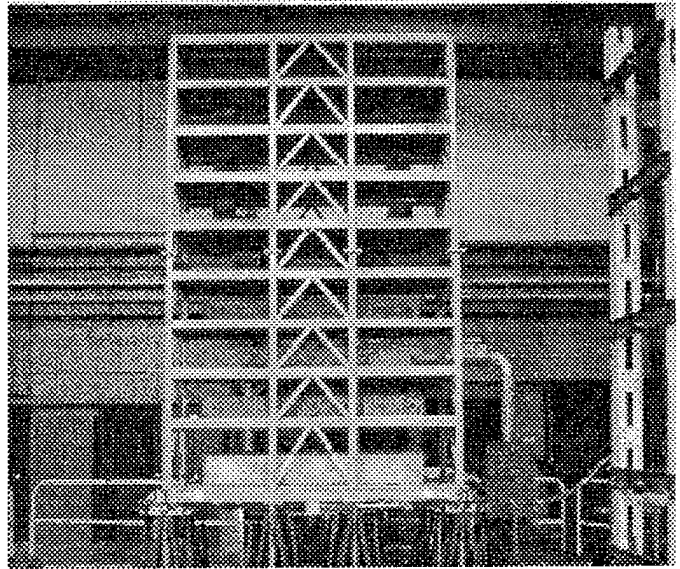
#### ***Triaxial Earthquake and Shock Simulator (TESS)***

In FY95, the original biaxial motion configuration of the CERL shaking table was upgraded into a full triaxial (3-D) motion capability. In FY96, TESS became operational. TESS accommodates more realistic earthquake and shock simulation environments than in its older configuration, permitting more detailed and accurate research on the response of structures to earthquakes. In FY97, the table was used to test equipment for IBM, Inc. under our technology assistance program for industry.

#### ***Unique Acoustics Research Facilities***

Noise is a major problem at many installations; lack of noise management has seriously jeopardized training capability. CERL has unique facilities for researching Army noise.

**Low Frequency Impedance Tube.** Army noise is largely produced by helicopters and artillery blast. This noise differs from typical environmental noise because it contains a great deal of

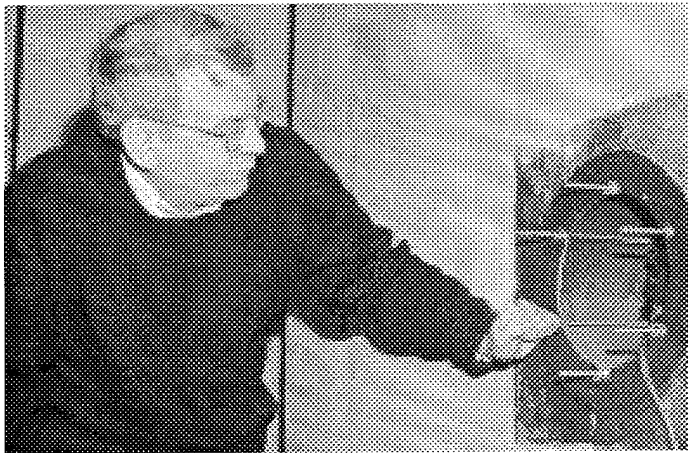


**Fig. 21: CERL's triaxial-motion shaking table accommodates realistic earthquake and shock simulation environments, permitting detailed and accurate research on structures' response to earthquakes. In FY97, the table was used to test equipment for IBM, Inc. under our technology assistance program for industry.**

energy at very low frequencies. CERL constructed a unique facility specially designed to investigate mitigation methods for very low frequency noise. This facility has been used to study the sound absorption characteristics of several materials at low frequencies; such data are not available from any other source.

**Acoustic Field Test Sites.** One benefit of CERL's affiliation with UIUC is our ability to use University property uniquely suitable for acoustic testing—very flat, grass-covered, free of obstructions, and located in very quiet rural areas. Other organizations, including the Federal Aviation Administration and the University of Mississippi, have carried out cooperative acoustic studies with CERL at these sites.

**Acoustic Laboratory Instrumentation.** Over more than 20 years, CERL has assembled an array of noise measurement and analysis equipment through frugal acquisition and careful maintenance, including equipment that became available when the EPA's Office of Noise Abatement and Control was disbanded. This significant noise instrumentation capability would cost several million dollars to duplicate.



**Fig. 22: The unique, CERL-constructed, low-frequency impedance tube was specially designed to investigate mitigation methods for very low frequency noise, such as those produced by helicopters and artillery blast. This facility has been used to study the sound absorption characteristics of materials at low frequencies—data are not available from any other source.**

#### *Heating, Ventilating, and Air-conditioning (HVAC) Test Facility*

HVAC systems are a major contributor to the Army's annual utility cost of over \$1.5 billion. CERL's HVAC Test Facility can be configured to replicate a variety of HVAC system types including single- or dual-duct and variable air volume (VAV) or constant volume. The facility controls consist of state-of-the-art digital controllers and is extensively instrumented. The facility was initially constructed with funding from the DOE. The test facility was recently used to investigate the performance of a Corps of Engineers standard digital control panel and to identify improved return fan VAV system control techniques.

#### *CERL Diurnal Ice Storage System*

The fielding this past year of our Diurnal Ice Storage System has helped keep our facilities on the cutting edge of facility operations innovation and rehabilitation. The system was installed through a cooperative effort involving the University of Illinois, Illinois Power Company, and CERL technical and support staff. The expected shift of electrical demand from on-peak to off-peak is 170 kW, resulting in an annual savings of \$15,000 for CERL in electrical utility bills. This system elicited enough interest from our local utility that they contributed \$50,000 to its completion. This computer-controlled system is

equipped with full monitoring instrumentation so CERL research staff can obtain data useful to its possible application on military bases.

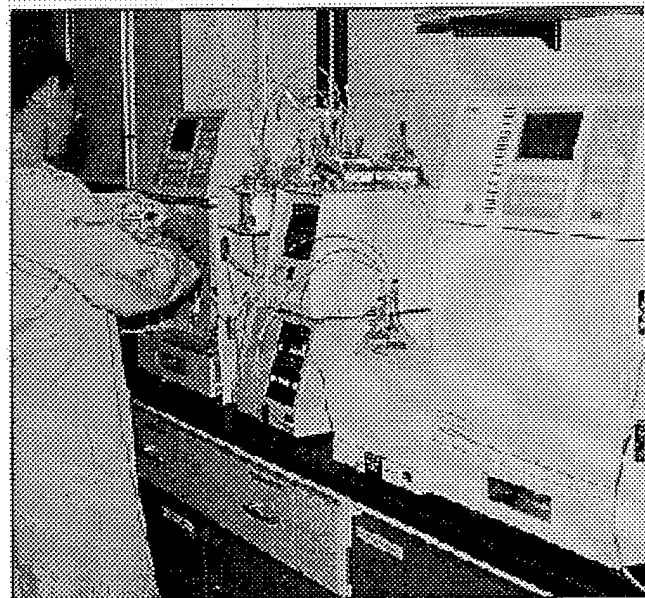
#### *Environmental Chemistry Laboratory*

Within the DoD, many projects require unique chemical assessment involving unknown compounds, complex assays, and multiple samples. Unknowns create special problems because commercial contracts must specify the exact procedures, compounds to be identified, and detection limits. CERL's Environmental Chemistry Laboratory (ECL) offers state-of-science equipment and expertise to meet customers' analytical needs.

Chemical analysis for environmental projects requires a variety of equipment, depending on the analyte nature, media composition, and the concentration. The ECL has many sophisticated instruments in house, and, as an allied agency of the University of Illinois, enjoys access to a vast array of analytical resources on campus, including tools for inorganic and organic analyses, as well as the ability to tailor analytical methods to meet customer needs.

#### *Collaboration Laboratory*

As part of the ongoing research into Collaborative Engineering, CERL has created an engineering software testing environment in which people can share design information as it is



**Fig. 23: CERL's Environmental Chemistry Laboratory offers state-of-science equipment, services, and expertise to meet customers' analytical needs.**



created. In this Collaboration Laboratory, facility designs are developed and refined by participants at geographically separated locations. This effort demonstrates how improved information sharing capabilities and conflict management during collaborative design enables a team to resolve design issues and conflicts earlier in the design process. This results in improved facility designs, fewer errors and omissions, and better interdisciplinary coordination of design goals and building systems.

#### *Electromagnetic (EM) Environment Simulator*

The EM Environment Simulator is a test facility that supports multiple research and development projects. The CERL simulator provides the unique capability of testing intermediate-sized structures, from sheet materials to full-sized facilities. During FY97, low-level continuous wave (CW) testing was continued to evaluate the EM characteristics of the simulator.

#### *CERL GIS Training Facilities*

The GIS training facilities at CERL can facilitate the training of a variety of public domain and commercial software packages. Training ranges from customized vendor and CERL-developed training in mission specific areas, to basic software courses that cater to a variety of technical areas. The training center hosted 9 courses and over 100 students in FY97 and several hundred more over the past 6 years since its creation.

#### *UIUC State of Art Equipment and Facilities*

Our relationship with the University of Illinois gives us access to their unique equipment and resources for R&D to complement our own unique equipment.

#### *Geographic Modeling Systems Laboratory*

The Geographic Modeling Systems (GMS) Laboratory at UIUC is supporting CERL and the Army in developing computer tools based on the integration of the next generation of GIS with landscape simulation models. The GMS laboratory personnel use digital models of the landscape to analyze direct relationships between military activities and the land.

#### *National Center for Supercomputing Application*

The UIUC National Center for Supercomputing Applications (NCSA) has evolved into a scientific research center built around a national services facility. NCSA is developing and implementing a national strategy to create, use, and transfer advanced computing and communication tools and information technologies. These advances serve the center's diverse constituencies in the areas of science, engineering, education, and business. NCSA works closely with the computer science research community to bring users the most advanced methods in high-performance scalable computing.

The center currently maintains these types of high performance systems: HP-Convex Exemplar S-Class, Silicon Graphics CRAY Origin2000, Silicon Graphics POWER CHALLENGE array, HP-CONVEX Exemplar SPP-1200, and Thinking Machines CM-5. NCSA's Virtual Environment Laboratory is one of the world's most advanced virtual reality research laboratories available to academic and industrial researchers.

#### *UIUC Grainger Engineering Library*

The new UIUC Grainger Engineering Library Information Center holds 190,000 volumes and more than 3,500 periodical subscriptions. It is supplemented by a series of departmental libraries including mathematics, physics, chemistry, and geology. The comprehensive University Library has the third largest collection among all U.S. academic libraries.

#### *HBCU/MI and Other Outreach Programs*

##### *Partnership Agreement with Clark Atlanta University (CAU)*

A Partnership Agreement established in FY95 was continued through FY97 with CAU, a historically black college or university (HBCU). Under this agreement, students are recruited to participate in the Summer Research Opportunity Program (SROP). Under this agreement, CERL also facilitates CAU faculty participation in CERL research programs.



### *University of Illinois Summer Research Opportunity Program (SROP)*

This program is designed to encourage minorities at universities and colleges to excel and graduate in their chosen fields, and to pursue graduate degrees. The students work for 2 months during the summer with professors or researchers and are paid a stipend of \$2500. At the end of that time, they are required to write and present a research paper to faculty and staff. The students also receive college credit for the work. CERL recruited and hired three students from CAU under this program in FY97.

### *Internship Science and Engineering Program (ISEP)*

ISEP is an outreach program developed in FY90 to encourage high school students to pursue careers in science and engineering. Students work full-time during the summer and 10 hours per week during the school year. They work with researchers in their areas of interest to gain experience and professional knowledge. Five students were hired under this program in FY97.

### *Embedded Sensor Systems*

The ability to determine the structural health of large civil engineering structures is critical to life safety. Clark Atlanta University is working with CERL to develop a low-cost, distributed sensing technique to determine the state of stress/strain, and the detection of significant levels of cracking in concrete structures. Based on electrical time domain reflectometry, the technique uses embedded coaxial cables, which are more suitable to heavy construction than fiber optic systems. CAU has characterized and modeled the embedded sensor systems and conducted photoelastic studies to establish the performance behavior of the sensors. They have begun an experimental study of the sensitivity of the technique to distinguish type and level of loading in concrete samples. When completed, the research will profoundly impact the Army and the construction industry as a whole. Structures containing these sensors will be able to be queried at any time to establish whether damage or deterioration (as from a seismic event or an

explosion) compromises the facility's safety. Moreover, pinpointing unsafe areas will make possible less costly spot repairs.

### *HVAC and Energy Research with NCA&TSU*

On 25 February 1997, CERL established a new partnership with another HBCU. A Partnership Agreement was signed with North Carolina Agricultural and Technical State University (NCA&TSU) to encourage and enhance research and study in mathematics, science, and engineering. In FY97, NCA&TSU completed a research project in support of CERL's ongoing efforts to develop workable energy technology infusion processes for the Army. The NCA&TSU project had three main focuses: (1) to develop an introductory 1-week HVAC training course, (2) to develop acceptance testing procedures for HVAC systems, and (3) to validate the benefits/savings resulting from completed lighting retrofit projects at two Army installations. Combined with other CERL work, the NCA&TSU project will lead to a workable process for installing and maintaining new energy technology in existing Army facilities.



**Fig. 24: CERL's Partnership Agreement with NCA&TSU will lead to a workable process for effectively installing and maintaining new energy technology in existing Army facilities.**

## 4 Continuous Improvement Process

### *Customer Satisfaction*

Customer satisfaction is a priority of CERL. In FY97, CERL employees received over 95 letters of appreciation from satisfied customers. This recognition came from several high-level individuals including LTG Joseph Ballard, Chief of Engineers; Paul W. Johnson, Deputy Assistant Secretary of the Army for Installations and Housing; and the Honorable Tommy G. Thompson, Governor of Wisconsin.

The results of our customer satisfaction surveys indicate a high level of satisfaction with CERL support. The surveys are sent out to customers after completion of individual reimbursable projects. In FY97, over 90 percent of our customers rated CERL as satisfactory or better in each of the eight service factors. The customers identify our strengths as being understanding their requirements (97.2% satisfaction rating) and executing within budget (95.7% rating), understanding their priorities (94.4% rating), and accessibility to CERL personnel (94.4% rating).

### *Process*

#### *Facilities Infrastructure Technology (FIT) Program*

The FIT Program became operational in FY96 with CERL fulfilling the lead role in managing the program. In FY97, the program focused on improved communication with both national and field representatives to the Technology Leadership Groups (TLGs). To better explain and gain input for the technology program being executed, the major activities for the TLGs were to: (1) obtain feedback and adjust the technology program, (2) expand field input and participation on the TLGs, (3) revalidate user requirements developed during FY96, and (4) focus on technology transfer (T<sup>2</sup>) planning. A FIT Lessons Learned and FY97 Planning Meeting was conducted in February 1997 to kick off the FY97 FIT cycle.

The Senior Infrastructure Leadership Council Working Group Leadership provided their perspectives on the Army's infrastructure and the installation of the future. Each TLG also gave a briefing on FY97 program status, followed by an open discussion on lessons learned.

#### *Environmental Quality Technology (EQT) Program*

CERL has a several mechanisms to obtain customer feedback. The EQT Pillar Technology Teams, consisting of representatives of the research, proponent, and user communities, were established to address life-cycle technology development from user requirements through technology development to technical support of fielded products. In FY97, CERL worked with other principle components of the Conservation Technology Team to develop a draft Life Cycle Technology Infusion Plan, which identifies technologies, techniques, and tools intended to support future conservation and environmental quality. The plan identifies products coming out of research and development, but also describes in detail the activities necessary to demonstrate, transfer, support, and maintain the products. Until now, this life-cycle approach has not been used for environmental technologies. The preparation of the draft plan included development of a more focused annual review process by the users of the technology that will be put into place in FY98.

CERL also gains customer feedback in the EQT program through customer advisory boards, composed of HQ, MACOM, and installation representatives, who focus on user requirements and provide direct input to research efforts through review of technologies under development. During FY97, two new boards were established, one a SERDP project to develop a risk assessment approach to land and resource management, and another by leveraging with the existing ITAM Installation Steering Committee to provide for review of erosion control and land carrying

capacity technologies coming out of the Corps labs.

### *CERL Customer Care Program*

In FY96, CERL fully implemented its Customer Care Program focusing on reimbursable projects. In FY97, CERL continued the implementation of its customer care reimbursable program. This program was established to improve communication and the quality of its service to CERL's reimbursable customers. Monitoring customer satisfaction is the cornerstone of the program. An improved proposal coordination process requires formal agreement on the deliverables, timetable, and budget for the project. Periodic in-progress reviews are conducted between CERL staff and the customer in which the customer provides a green, amber, or red rating to the ongoing work. The reviews improve communication with the customer and allow CERL to continue to be responsive to changing needs of its customers. A survey is sent out at the completion of the project to get a final assessment of customer satisfaction and input for continuous improvement. At our annual Allerton Management Retreat, several key customers gave input on their future initiatives. This input has been used in developing the FY98 customer support strategies.

### ***Accountability and Personnel Linked to Process***

#### *In-Progress Reviews for Reimbursable Projects*

CERL's Reimbursable Customer Care Program emphasizes the need to keep the sponsor informed of work unit progress throughout its life using In-Progress Reviews (IPRs). IPRs are scheduled during each work unit to ensure the work is on track and aligned with customer expectations. Each IPR is documented through a standard form to be signed by both the researcher and the sponsor. Individual IPR plans for each reimbursable project are developed for each project and put in the "Milestones" section of the proposal.

The IPR plan is to be approved by the sponsor technical POC and the division chief during review of the draft proposal.

#### *MACOM Quarterly Reports*

CERL improved upon the process for sending quarterly status reports to headquarters personnel at MACOMs and expanded the distribution list. The quarterly status reports provide a summary of the reimbursable projects being completed for installations within that command. CERL initiated the reports in FY97 in response to customer input as a means to improve communication on its activities with key customers.

#### *Assessment of Customer Surveys Results – Customer Issue Alerts*

The results of customer satisfaction surveys are carefully reviewed by management and employees. Certificates of "Excellence in Customer Service" are sent to employees who have received a #1 rating in all eight customer service factors on the surveys.

Surveys with negative comments are sent to management for action via "Customer Issue Alert" memoranda with a 1-month suspense for follow-up action. Criteria for Customer Issue Alerts reflect high expectations for high quality support to our customers. Lab management contacts the customer to assess issues related to the dissatisfaction and develop action plans working with employees to address the issues.

#### *Annual APIC Automated Assessment*

In FY97, CERL conducted its fourth internal self-assessment using the APIC Automated Assessment Tool (AAT). The AAT was developed at CERL and has been used by over 45 Army organizations in measuring continuous improvement. The survey reflects the perception of employees in how well the organization meets the APIC standards. This years AAT scores demonstrate improvement in six out of the seven areas.

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